FIFTY-SECOND ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

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R. Y. WINTERS, Director

U.S.D.A.

THE NORTH CAROLINA STATE COLLEGE
OF AGRICULTURE AND ENGINEERING
AND
STATE DEPARTMENT OF AGRICULTURE
COOPERATING

STATE COLLEGE STATION
RALEIGH

FOR THE
FISCAL YEAR ENDED, JUNE 30, 1929
STATISTICAL SUMMARY FOR YEAR ENDING,
DECEMBER 1, 1929

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LETTERS OF SUBMITTAL

STATE COLLEGE STATION,
RALEIGH, N. C.

PRESIDENT E. C. BROOKS,
North Carolina State College of Agriculture and Engineering,
State College Station, Raleigh, N. C.

DEAR SIR:

I have the honor to submit herewith the annual report of progress in agricultural research of the Agricultural Experiment Station of the North Carolina State College of Agriculture and Engineering and the North Carolina State Department of Agriculture. The report contains recommendations for strengthening research and a summary of results accomplished at the Central and Branch Stations during the fiscal year ending June 30, 1929.

Respectfully yours,

R. Y. WINTERS, *Director.*

COPY.

RALEIGH, N. C.

HONORABLE O. MAX GARDNER,
Raleigh, North Carolina.

MY DEAR GOVERNOR:

I take pleasure in transmitting to you the Fifty-second Annual Report of the North Carolina Agricultural Experiment Station. The report records the accomplishments of agricultural research for the year ending June 30, 1929.

The work of the past year has been conducted in accordance with the program approved by the Experiment Station Committee.

Very sincerely yours,

(Signed) E. C. BROOKS, *President.*

EXPERIMENT STATION COMMITTEE

(Appointed by Board of Trustees of College)

D. J. Lybrook, Advance, N. C.
Harry V. Latham, Belhaven, N. C.
W. D. Laroque, Kinston, N. C.
J. S. Matthews, Virgilina, Va.
W. A. Bullock, Red Springs, N. C.
Dr. L. J. Herring, Wilson, N. C.
David M. Buck, Bald Mountain, N. C.

(Appointed by State Board of Agriculture)

S. C. Lattimore, Shelby, N. C.
W. A. Brown, Rocky Mount, N. C.
E. G. Roberson, Leicester, N. C.
F. P. Latham, Belhaven, N. C.

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OFFICERS AND STAFF

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

JANUARY 1, 1929

E. C. Brooks.....*President of the College*
I. O. Schaub.....*Dean of the School of Agriculture*
R. Y. Winters.....*Director*
C. B. Williams.....*Vice-Director*
†F. E. Miller.....*Director of Branch Stations*
F. H. Jeter.....*Agricultural Editor*
A. F. Bowen.....*Treasurer*

Agronomy

E. F. Goldston.....*Assistant in Soil Survey*
†F. O. Bartel.....*Drainage Engineer, in Coöperation with U. S. Department of Agriculture*
A. S. Cline.....*Assistant in Soil Fertility Investigations*
W. A. Davis.....*Assistant in Soil Survey*
R. B. Devereaux.....*Assistant in Soil Survey in Coöperation with U. S. Department of Agriculture*
G. M. Garren.....*Assistant in Plant Breeding*
R. C. Journey.....*Assistant in Soil Survey, in Coöperation with U. S. Department of Agriculture*
P. H. Kime.....*Assistant in Plant Breeding*
H. B. Mann.....*Assistant in Soil Fertility Investigations*
E. G. Moss.....*In charge Tobacco Investigations for the State Department of Agriculture and U. S. Department of Agriculture*
C. B. Williams.....*Agronomist*
L. G. Willis.....*Soil Chemist*
J. R. Piland.....*Assistant Chemist*
R. Y. Winters.....*Plant Breeder*
J. H. Moore.....*Cotton Technologist*

Animal Industry

C. D. Grinnels.....*Dairy Investigator*
J. O. Halverson.....*In charge Animal Nutrition*
E. H. Hostetler.....*Swine Investigator*
R. H. Ruffner.....*Head, Animal Industry*
F. H. Smith.....*Assistant in Animal Nutrition*
F. W. Sherwood.....*Associate in Animal Nutrition*

Agricultural Economics

R. C. Campbell.....*Cotton Marketing Specialist*
G. W. Forster.....*Economist*
J. G. Knapp.....*Asso. Agricultural Economist*
P. H. Rogers.....*Asso. Agricultural Economist*

Botany

S. G. Lehman.....*Plant Pathologist*
R. F. Poole.....*Plant Pathologist*
B. W. Wells.....*Botanist*

Horticulture

J. H. Beaumont.....*Horticulturist*
M. E. Gardner.....*Assistant Horticulturist*
Robert Schmidt.....*Associate Horticulturist*
C. F. Williams.....*Associate Horticulturist*

Poultry Husbandry

W. G. Crowder.....*Poultryman*
R. S. Dearstyne.....*Associate Investigator and Pathologist*
B. F. Kaupp.....*Poultry Investigator and Pathologist*

Rural Sociology

*W. A. Anderson.....*Sociologist*
C. C. Taylor.....*Sociologist*

Zoology and Entomology

B. B. Fulton.....*Associate Entomologist*
Z. P. Metcalf.....*Entomologist*

Central Station

R. J. Harris.....*Foreman*
F. E. Miller.....*Director of Branch Stations*

†Branch Stations

Blackland Test Farm

J. L. Rea, Jr.....*Assistant Director in Charge*

Coastal Plain Test Farm

Chas. Dearing.....*Assistant Director in Charge*

Mountain Test Farm

S. C. Clapp.....*Assistant Director in Charge*

Piedmont Test Farm

F. T. Meacham.....*Assistant Director in Charge*

Tobacco Test Farm

E. G. Moss.....*Assistant Director in Charge*

Upper Coastal Plain Test Farm

R. E. Currin, Jr.....*Assistant Director in Charge*

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* On Leave.
† Workers and Branch Stations under authority of the State Department of Agriculture, coöperating with the Agricultural Experiment Station in research.

FIFTY-SECOND ANNUAL REPORT

OF THE

NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION

FOR THE

YEAR ENDING JUNE 30, 1929

By R. Y. Winters, *Director*

This report contains a record of work done and results secured by departments of the Experiment Station during the year beginning July 1, 1928, and ending June 30, 1929. With the exception of a few summaries of previous results, the records apply to this period only and are not regarded as conclusive.

The Station staff coöperated in a careful examination of the research program during the past year. All project outlines were studied with reference to present day problems confronting farmers of the state and in the light of existing knowledge. This examination resulted in the following changes and revisions in the research program:

1. The dropping of projects that have matured.
2. Preparing results for publication.
3. Dropping projects which have not given profitable returns.
4. Strengthening the attack upon a few problems important to the state and region by supplying better support and arranging coöperative efforts between one or more departments of the Station and with the U. S. Department of Agriculture.

These revisions of the program and the additional $10,000 from the Federal Purnell Fund has made it possible to give better support to the more important lines of work and to take up a few new problems.

At the request of growers in the eastern part of the state, new studies have been started with peanuts, sheep, and the tobacco disease known as "mosaic." Requests from the fruit growers of the Sandhill region has resulted in the starting of more intensive studies of diseases and plant food problems confronting the peach and and dewberry growers.

The program for the benefit of agriculture in the Piedmont region has been materially strengthened by the addition of studies with alfalfa, red clover, lespedeza, and other legumes as sources of forage. This is being conducted in coöperation with the Office of Forage Crop Investigations, of the U. S. Department of Agriculture. Pasture fertilization and grazing studies conducted in coöperation with the Synthetic Nitrogen Products Corporation is also a new project which should be of value to dairymen of the Piedmont region.

In the Mountain region new work has been started for the development of better adapted strains of Irish potatoes and for the establishment of certified seed producing areas in this section. This work is being conducted in coöperation with the U. S. Department of Agriculture and several state experiment stations, making it possible to exchange promising strains of the Irish potato with these institutions and thus extending the usefulness of the investigations.

The examination of the general program has taken into consideration the importance of making available the results of past research. This has stimulated workers to bring up to date information which is much needed at this time. These efforts have already yielded results since more material has been prepared than can be printed by the funds available for this purpose. Much of the information has been summarized in the form of mimeographed reports, news articles, and discussions before county agents, vocational teachers and farmers.

The research workers have coöperated with the Extension Specialists, and others, in the preparation of a state-wide agricultural program and have supplemented the program with information which will be of value in applying it to farm practice of our state.

CHANGES IN THE STAFF

J. J. Morgan, assistant in Soil Survey, resigned May 1, 1929, to go with the State Department of Agriculture. He has been succeeded by E. F. Goldston, who began work June 1. Dr. R. J. Saville, assistant in agricultural economics, resigned, effective June 30, 1929, to accept a position with the Louisiana Experiment Station, and has been succeeded by R. H. Rogers, formerly connected with the South Dakota College of Agriculture and Mechanic Arts.

NEEDS OF THE EXPERIMENT STATION

That certain workers are attempting to carry too many research projects has been pointed out in previous reports. This is due in part to the lack of workers in many important fields. A more specific statement of these conditions will help to show the needs.

1. The Station has no provision for research in agricultural engineering. The problems concerned with labor-saving implements, soil erosion and farm buildings are a very important part of our agriculture and should receive attention. If such work were provided for by the State the coöperation of the U. S. Department of Agriculture could undoubtedly be secured in the solving of certain of the problems under this head. In 1927, thirty-two states were maintaining research in this field at an average cost of approximately ten thousand dollars.

Evidence at hand indicates that the cotton growers of our state are suffering considerable loss from present ginning practices. This should be thoroughly studied with the idea of reducing the loss.

2. Funds available are not sufficient to provide for the study of forage crops and pastures. Considerable information has been secured but more definite work should be done in the principal agricultural areas of the state. The future of livestock in the state is largely dependent upon the economical production of forage crops and pastures.

3. Much research is needed in the study of animal diseases and parasites which are unusually destructive to domestic animals of the South. With the exception of investigations by the U. S. Department of Agriculture, little information is available for the control and prevention of animal diseases and parasites peculiar to the South.

4. The growing interest in local commodity coöperative marketing associations such as the potato growers of the northeastern part of the state and the peach growers of the Sandhill region appear to be in the right direction. Coöperative marketing organizations may be effective in the improvement of quality and proper standardization of farm produce. They may also supply better means of distribution and adjusting supply to demand. In order that the coöperative marketing movement in the state may proceed with the least difficulty it is necessary that thorough studies be made of those organizations now in operation. It is also important that other agricultural products be studied with relation to their present marketing needs. This work will require more time than can be provided by the present budget.

Research Facilities Needed

1. Less than ten acres of the one hundred and fifty acres of the Station farm are suitable for field plat experiments because of the irregular soil and contour. The following areas are needed for the completion of projects now under way.

Agronomy	25 acres
Horticulture	25 acres
Plant Diseases	10 acres

A study of the land available for Experiment Station work in thirty-one eastern and mid-western states indicates that the average is approximately 1000 acres.

2. The present laboratory for soils research is inadequate for this purpose, and is now shared with advanced students in soils.

3. The field crop research is in need of storage and laboratory facilities. The seed storage and laboratory is now in the basement of Ricks Hall, where the equipment and seed are exposed to excessive moisture, and sometimes flooded. The cotton fiber studies are being done in an office 8x10 in size. The room is too small for laboratory work and does not provide storage for valuable apparatus and materials.

4. During the years of 1915 to 1927 the Station received through legislative appropriation approximately $2,000 annually for printing. This included $1,250 for printing bulletins plus the cost of printing the annual report. Although submitted in the College budget, this fund has not been available since 1927. The loss of this fund has materially crippled the distribution of information gained by research. The bulletin issues are now too small to supply the demands of county agents, vocational teachers, their students and farmers. The average appropriation from State sources for Experiment Stations of our country for this purpose in 1927 was $4,398 per year.

5. The swine research is isolated on a small farm four miles from the College, detached from other livestock investigations and farm operations. This increases the overhead expenses of this research and prohibits swine studies in relation to other farm enterprises. A consolidation of this work with the beef cattle and sheep work would reduce the labor and overhead charges to these projects.

6. Two years ago additional greenhouse facilities were supplied the department of horticulture and two small units were made available for the departments of agronomy and botany. These greenhouses have materially strengthened the research program in these departments. The work in plant diseases would be materially strengthened if provision could be made for another small greenhouse unit for the study of diseases which develop at lower temperatures.

DIVISION OF PUBLICATIONS

Distributing authoritative information obtained from workers in the North Carolina Experiment Station is one of the principal duties of the Division of Publications. The division sends out a series of timely news items to the daily press of North Carolina each week. Many of these are based on research done by some member of the Station staff. The weekly press of North Carolina is also supplied a series of four articles each week. Much of this also comes from information supplied by research workers.

Signed articles on Monday farm pages and feature articles for Sunday papers are other parts of the news work done for the Experiment Station. The Division of Publications seeks to place all results of research work before the people of the State as soon as they are released by the men who have the projects in charge.

In addition to the news releases, the division also edits and distributes the bulletins of the Station. Lack of funds has prevented the publishing of many important publications but it is hoped that this condition can be remedied. It is only fair that when money is spent for research that some money be spent also to make this information available to the rank and file of farmers and agricultural leaders.

During the calendar year ending December 31, 1929, the Office of Publications handled nine publications for the Agricultural Experiment Station. These included six of the regular series, two of the technical series and one annual report for a total edition of 32,500 copies. These publications were edited, proof-read and handled through the printer. As most of the bulletins were voluminous, the time element in handling them is a matter of consideration.

Of this total edition 9,900 were mailed to the regular mailing lists and 9,200 mailed to individuals upon request. Requests for former bulletins, available for distribution, were received totaling 11,980 making a grand total of 31,080 publications mailed during the year.

Service Work

The service work completed for Station workers includes mimeographing and multigraphing circular letters, cards and office letterheads in addition to the handling and supervision of all small printing. During the year the office has multigraphed or mimeographed:

92,000 circular letterheads for the Department of Agronomy. This included many issues and re-issues of the Information Circular series.
54,250 circular letters for other offices.
4,900 cards.
8,500 letterheads for office use.
9,500 letterheads for circular letter work.

Small printing handled included Station bulletin envelopes, report forms for the Animal Husbandry Department and envelopes and special letterheads for various offices. Paper stock is also furnished the various offices.

A careful check is kept of this and the Departments given a statement of their account each six months. This means that a set of accounts for each office has to be kept in this office.

The complete list of publications printed and distributed by the Experiment Station for the year ending June 30, 1929, is as follows:

GENERAL BULLETINS

No.	*Title*	*No. Copies*
257	Response of Oats and Soybeans to Manganese	3,500
258	Living Conditions among White Land-Owner Operators in Wake County	2,500
259	Soybean Oil Meal for Fattening Pigs	3,000
260	Systems of Livestock Farming for the Mountain Regions in North Carolina	3,000
261	Value of Lime on Cecil Clay Loam Soil	3,000
262	Value of Lime on Norfolk Sandy Loam Soil	3,000
263	Growing Quality Sweet Potatoes	5,000
264	Causes of Poultry Mortality in N. C.	4,000
265	The Nematode Disease of Sweet Potatoes	2,500
266	Synthetic Nitrogen Salts as Sources of Nitrogen	4,000
267	Farm Income and Taxation in North Carolina	5,000
	51st Annual Report	1,500

TECHNICAL BULLETINS

31	A New Poultry Disease	3,000
32	A Southern Grass Sedge Bog	2,000
33	A Method for Measuring the Drag of Cotton Fibers	2,500
34	Agglutination and Pathological Studies in B.W.D.	2,500
35	Chemical Control for Sweet Potato Wilt or Stem Rot	4,000
36	Study of Bacillary White Diarrhea and its effect upon the Flock	3,000

AGRONOMY INFORMATION CIRCULARS

(1) No. 17. How to Maintain a Supply of Pure Cotton Seed on the Farm, by P. H. Kime.
(2) No. 18. Important Soils of North Carolina and Their Distribution and Plant Food Needs, by C. B. Williams.
(3) No. 19. What One-third of the Counties of North Carolina have Done and are Doing, by C. B. Williams.
(4) No. 20. Results of Cotton Variety Demonstrations, by P. H. Kime and S. J. Kirby.
(5) No. 21. The Quality and Yield of Cotton as Influenced by Fertilizers and Soil Type, by J. J. Skinner.
(6) No. 22. New Fertilizer Materials and Their Uses, by J. J. Skinner.
(7) No. 23. Plan of Organization Used in the Community-Improvement of Cotton in North Carolina, by P. H. Kime.
(8) No. 24. Installation of Hydraulic Rams, by D. S. Weaver.
(9) No. 25. Varieties of Corn Recommended for North Carolina, by G. M. Garren.
(10) No. 26. Growing Lespedeza in North Carolina, by P. H. Kime and E. C. Blair.

TECHNICAL PAPERS

25. Frog-eye Leaf-spot of Soybeans Caused by Cercospora Diazu Miura (Lehman) Jr. Agr. Res., Vol. 26, No. 9.

26 The Blood Groups of the Jamaicans (Snyder) Published as a chapter in "Race Crossings in Jamaica," Carnegie Institute, Washington, D. C., Pub. No. 395, Pages 277-281.

27 Sex anomalies of the Genus Megachile (Mitchell) Published in "Transaction of the American Entomological Society, March 1929, Vol. 54, pages 321-383.

F. H. JETER,
Agricultural Editor.

RESEARCH IN AGRICULTURAL ECONOMICS
1929-30

The Department's efforts in the past have been devoted mainly to the work in Farm Organization and Management. Beginning with 1928, the scope of the research work was broadened to include projects in marketing, agricultural finance, farm income, taxation, and cost of producing farm products. The active projects are:

1. A study of the Organization and Management of Farms in various sections of the State.
2. The Organization and Management of Farms Operated by Croppers.
3. Methods and Practices Employed in the Production of Cotton and Tobacco.
4. Cost of Producing Strawberries.
5. Cost of Producing Farm Products.
6. Farm Credit.
7. Farm Taxation.
8. Farm Income.
9. The Marketing of Cotton.

FARM ORGANIZATION AND MANAGEMENT

The projects in this field, completed or in progress, are as follows:

1. Coastal Plain. (Johnston, Harnett and Cumberland counties) Completed.
2. Lower Coastal Plain (Craven County) Completed.
3. Mountain Area (Macon County) Completed.
4. Coastal Plain (Northampton County) In progress.
5. Piedmont (Wake County) In progress.

The major objective of these investigations have been to determine for each important area of the State the combinations of crops and livestock which would yield the maximum long-time net returns. The results obtained in the case of the first three projects have been published. (See Research Bulletin No. 1, Station Bulletin No. 252 and Station Bulletin No. 260.) The combinations suggested are presented in Table I. These combinations follow closely the organization of the most successful farms in the area to which they apply. In calculating the returns, normal yields and prices have been used rather than average prices and yields, or yields and prices for any given year. The object of setting up these standard crop and livestock combinations is to furnish a practical guide to farmers in reorganizing their farms, in order to obtain the maximum use of their resources.

ORGANIZATION AND MANAGEMENT OF FARMS OPERATED BY CROPPERS

It is the purpose of this project to study in detail the organization and management of approximately 100 farms which are operated by cropper labor, in such a way as to throw light on the tenant and cropper problem, and on the basis of the information obtained to suggest plans for improving the organization and management of such farms. It is proposed not only to

TABLE I.—SUGGESTED CROP AND LIVESTOCK COMBINATIONS FOR VARIOUS AREAS OF NORTH CAROLINA

	COASTAL PLAIN						TIDEWATER[5]				MOUNTAIN[8]			
	Crop acres in Farm[1]			Crop acres in Farm[2]				Crop acres in Farm				Crop acres in Farm		
Acres	30	50	80	40	60	90		40	60	70[7]		30	40	60
CROPS:							CROPS:				CROPS:			
Cotton	10	15	16	8	10	20	Tobacco	12	15	----	Wheat	7	5	8
Peanuts	----	----	----	10	16	25	Corn, Soybeans	24	38	25	Rye	----	10	12
Tobacco	4	5	6	----	----	----	Soybeans	----	----	34	Corn	9	14	22
Corn and Soybeans	10	20	40	20	30	40	Oat Hay	4	7	8	Oat Hay	2	2	4
Oat Hay	6	10	18	2	4	5	Legume Hay[6]	4	7	8	Soybean Hay	3	5	7
Soybean Hay[3]	6	10	12	----	----	5	Other Crops	----	----	3	Cowpea Hay	3	----	----
											Meadow	4	7	3
LIVESTOCK:	No.			No.			LIVESTOCK:	No.			LIVESTOCK:	No.		
Workstock	2	3	4	2	3	4	Workstock	2	3	3	Workstock	2	3	3
Dairy Cows	2	5	8	2	5	5	Dairy Cows	2	3	5	Dairy Cows	5	6	8
Young Cattle	----	2	4	----	2	2	Other Cattle	----	2	4	Other Cattle	2	4	5
Sows	2	4	4	4	6	8	Sows	3	9	9	Sows	2	2	3
Shoats	16	32	92	48	72	96	Shoats	46	70	70	Shoats	16	16	24
Poultry	75	100	150	125	200	200	Poultry	125	150	150	Poultry	65	75	150
											Sheep	----	10	21
RESULTS:							RESULTS:				RESULTS:			
Receipts	$ 2854	$ 4330	$ 6878	$ 3681	$ 5329	$ 8116	Receipts	$ 4555	$ 5968	$ 3099	Receipts	$ 1731	$ 2149	$ 3099
Expenses[4]	477	1118	2400	880	1348	1839	Expenses[4]	1123	1663	1264	Expenses[4]	459	599	917
Returns	$ 2377	$ 3212	$ 4478	$ 2801	$ 3981	$ 6277	Returns	$ 3432	$ 4305	$ 1835	Returns	$ 1272	$ 1550	$ 2182

[1]Data from Johnston and Harnett counties.
[2]Data from Northampton County.
[3]Soybean hay follows oats.
[4]Does not include family labor or operator's labor.
[5]Craven County.
[6]Follows oats.
[7]Combination not including tobacco.
[8]Macon County.

present the important facts relating to crop acreages, crop rotations, farm investment, production, receipts, expenses, and income, but also, to inquire into the rental and financial arrangements between owners and croppers.

Detailed records were obtained, by personal interviews, from 112 farm owners and 230 croppers on the same farms. The following table shows the location and the size of the farms studied.

TABLE II.—NUMBER, LOCATION AND SIZE OF FARMS

County	Number of Farms	Number of Cropper Records	Number of Croppers on Farms	Average Size of Farms
Pitt	27	60	146	334
Edgecombe-Halifax	26	76	224	664
Wayne	30	44	111	292
Lenoir	29	50	107	269
Total	112	230	588	383

From the farm owners and managers, information was obtained covering the management and organization of the farm as a whole, including a complete financial record of the farm business for the year 1928. Records were secured from croppers on their individual crops, the receipts, expenses, property owned, length of residence on the farms and other facts relating to tenure. A farm business summary for the records obtained in Pitt County is given below.

TABLE III.—FARM BUSINESS SUMMARY

Average for 27 farm owners and 60 croppers, Pitt County, 1928

	Crop Acreage Per Farm	Value of Farm Property[1]	Total Farm[2] Receipts	Farm Expenses	Farm Income
27 Farm Owners	155	$ 30,506	$ 12,007	$ 8,837	$ 3,170
60 Croppers	25	90	1,395	625	770

[1]The property of the croppers included the value of livestock, tools, and supplies.

[2]Total farm receipts included the value of family living from the farm to the average amount of $533 for the owners and $229 for croppers.

In addition to the regular farm business records, information was obtained on the extension of credit to croppers, the rental contract, length of tenure, and other matters relating to the management of cropper labor. The table presented gives pertinent facts regarding the amount and cost of credit, extended to croppers on 27 Pitt County farms in 1928. The cost figures or interest rates and time charges are astonishing, ranging from 19.1 per cent for cash advances to 72.9 per cent for supplies advanced by merchants.

TABLE IV.—AMOUNT AND COST OF CREDIT USED BY CROPPERS
146 Croppers on 27 Pitt County Farms, 1928

Source and Type of Credit	Total Amount of Credit by Source	Average Amount of Credit Used by Source		Weighted Average Cost of Credit Per Annum
		Per Farm	Per Cropper	
Cash Advances by Farm Owners	$ 6,415	$ 238	$ 44	19.1%
Farm goods, fertilizer, etc., by farm owner and merchant	18,205	674	125	36.1
Household goods, food, etc., by farm owner	18,006	667	123	71.2
Household goods, food, etc., by merchant on owner's guarantee	13,940	516	96	72.9
Total Advances	$ 56,566	$ 2,095	$ 388	50.5%

In a consideration of the credit costs, it is well to remember that farms and supply stores grant allowances of $20 to $40 per month in cash or supplies to croppers for the period of the crop season. In addition to the time price for goods, there is in many cases a flat charge of 10 per cent on the total amount of advances for the year regardless of the length of time for the loan. The custom varies with the locality and the ability of the individual. The best men may obtain goods at lower time prices than others or may be charged only the cash price plus interest. Risks and losses are great and rates in the long run will be sufficient to protect the farm operator and merchant against bankruptcy in poor crop years.

METHODS AND PRACTICES IN THE PRODUCTION OF COTTON AND TOBACCO

The field work on this project will begin January 1, 1930. The object of the study is to determine the effect of variation in methods and practices on the cost of production, and from the information obtained to show how these crops may be produced more profitably.

COST OF PRODUCING STRAWBERRIES

This project has been completed. The data have been analyzed and the bulletin is in preparation. The object of the study was to determine the effect of variation in practices on the cost of producing strawberries in the Chadbourne, Duplin and Pender areas. A summary of the results is given in tables V and VI.

COST OF PRODUCING FARM PRODUCTS

The data used in this study were obtained in connection with the Farm Organization and Management investigation referred to above. The data are being analyzed and the results will be ready for publication during the year.

TABLE V.—ESTIMATED COST OF LABOR, MATERIALS AND OTHER ITEMS FOR DEVELOPING AND OPERATING AN ACRE OF STRAWBERRIES, CHADBOURN DISTRICT, NORTH CAROLINA.[1]

Item	First Year	Second Year	Third Year	Total for three years.
	Expenses	Expenses	Expenses	Total Expenses
Pre-harvest labor and power	$ 63.94	$ 45.57	$ 45.57	$155.08
Harvest labor and power	85.10	85.10	62.85	233.05
Materials	79.00	74.75	64.75	218.50
Miscellaneous Expense	30.75	29.70	29.06	89.51
Total all costs not including interest	258.79	235.12	202.23	696.14
Interest Charges	9.00	9.00	9.00	27.00
Total including interest	267.79	244.12	211.23	723.14
Cost exclusive of interest F. O. B. local station:				
per quart	.090	.082	.097	.089
per 32 quart crate	2.88	2.61	3.11	2.84
Cost including interest F. O. B. local station:				
per quart	.093	.085	.102	.092
per 32 quart crate	2.98	2.71	3.25	2.95

[1]Costs based on 1928 rates for labor, horse work, materials and other items and on a common method of developing and handling bearing fields. Fields studied ranged from 1 to 20 acres in size, averaging about 5 acres.

TABLE VI.—ESTIMATED COST OF LABOR, MATERIALS AND OTHER ITEMS FOR DEVELOPING AND OPERATING AN ACRE OF STRAWBERRIES, DUPLIN AND PENDER COUNTIES, NORTH CAROLINA.[1]

Item	First Year	Second Year	Third Year	Total for three Years
	Expenses	Expenses	Expenses	Total Expenses
Pre-harvest labor and power	$ 71.29	$ 43.66	$ 43.66	$158.61
Harvest labor and power	102.00	102.00	77.75	281.75
Materials	81.72	77.50	67.00	226.22
Miscellaneous Expenses	25.37	23.85	23.05	72.27
Total all cost not including interest	280.38	247.01	211.46	738.85
Interest charges	9.00	9.00	9.00	27.00
Total including interest 32 quart crates	289.38	256.01	220.46	765.85
Cost exclusive of interest F. O. B. local station:				
per quart	.088	.077	.088	.084
per 32 quart crate	2.80	2.47	2.82	2.69
Cost including interest F. O. B. local station:				
per quart	.090	.080	.092	.087
per 32 quart crate	2.89	2.56	2.94	2.78

[1]Costs based on 1928 rates for labor, material and other items on a common method of developing and handling bearing fields. Fields studied were from 1 to 40 acres in size averaging about 7 acres.

FARM CREDIT

The major objectives of this study were—(1) to determine cost of credit to farmers; (2) the effect of this cost on returns from farming; and, (3) to suggest methods by which credit cost might be reduced. The study covers the farm credit situation in 1926 for selected areas in North Carolina. The field work was done jointly by the United States Department of Agriculture and the North Carolina Experiment Station. A manuscript has been prepared by David L. Wickens of the U. S. Department of Agriculture, and G. W. Forster of the North Carolina Experiment Station. A bulletin will be published in the near future.

The cost of various types of credit is shown in Tables VII and VIII. Merchant credit, on the average, cost farmers 25 per cent. Of various types of merchant credit, store credit was the most costly, being 28.5 per cent. Credit extended by fertilizer agents cost 22.7 per cent, that furnished by landlords 10.1 per cent and credit from miscellaneous sources 12.9 per cent. In contrast to the merchant credit the cost of cash loans was much lower. On the average, cash loans cost 7.7 per cent. Loans obtained from banks cost 8.1 per cent, from agricultural corporations 11.3 per cent, from landlords 7.1 per cent, from insurance companies 6 per cent, and from miscellaneous sources 8.9 per cent.

TABLE VII.—Cost of Cash Loans According to Source[1] Used in 1926

	Cost of all Cash Credit	Banks	Agricultural Credit Corporations	Landlords and other Individuals	Insurance Co.	Other Sources
	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)
All Farmers	7.7	8.1	7.3	7.1	6.0	8.9
Owners	7.6	8.2	7.3	6.2	6.0	8.9
Tenants	8.2	7.1	----------	10.3	----------	----------
Area 1	6.2	6.3	----------	6.0	----------	----------
Owners	6.2	6.3	----------	6.0	----------	----------
Tenants	6.2	6.2	----------	6.0	----------	----------
Area 2	10.3	10.4	6.2	11.1	----------	----------
Owners	10.8	11.1	6.2	7.9	----------	----------
Tenants	8.7	6.8	----------	12.4	----------	----------
Area 3	7.5	7.4	7.4	10.5	6.0	8.9
Owners	7.3	6.9	7.4	10.0	6.0	8.9
Tenants	9.9	9.6	----------	10.7	----------	----------

[1]Includes credit carried over from previous year.

An encouraging feature of the credit situation is that farmers are apparently using more cash and less merchant credit than formerly. The trend of credit sales to farmers, as reported by merchants (See Table IX) decreased steadily from 1914 to 1926. In 1914 credit sales were 86.2 per cent of the total sales, while in 1926 such sales amounted to only 60 per cent, a decline of 26.2 points.

TABLE VIII.—COST OF MERCHANT LOANS ACCORDING TO SOURCE[1] USED IN 1926

	Cost of all Merchant Credit	Store	Fertilizer Co.	Landlord	Other Sources
	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)
All Farmers	25.0	28.5	22.7	10.1	12.9
Owners	27.7	28.8	19.5		
Tenants	21.0	27.4	38.5	10.1	12.9
Area 1	22.0	21.7	27.2		
Owners	20.9	20.8	23.1		
Tenants	23.7	23.1	29.9		
Area 2	27.9	43.8	12.9	9.5	12.9
Owners	35.9	45.2	12.9		
Tenants	16.8	38.5		9.5	12.9
Area 3	26.5	25.6	57.5	14.2	
Owners	26.3	25.1	56.1		
Tenants	27.8	30.0	60.7	14.2	

[1]Includes credit carried over from previous year.

From the investigation, it is evident that farmers can improve their credit situation by—(1) reducing the amount of credit used, (2) saving a larger proportion of their income, thereby being more independent of merchants, (3) shifting the source of credit from time-lending agencies to cash-lending institutions, (4) by confining their borrowing to a strictly per annum rate, and, (5) substituting long-term mortgages for short-term borrowing.

FARM TAXATION

The project in Farm Taxation was conducted in coöperation with the United States Department of Agriculture and the North Carolina Tax Commission. The results have been published in Station Bulletin No. 267. This bulletin deals with three important phases of agricultural taxation, (1) the per cent of net income of farmers absorbed by taxes, (2) the per cent of net returns absorbed by taxes, and (3) the assessment and equalization of farm property assessed by taxes.

TABLE IX.—TREND OF CREDIT SALES TO FARMERS, AS REPORTED BY MERCHANTS

North Carolina	Total sales to farmers	Credit Sales to Farmers					
		1926	1925	1924	1923	1922	1914
	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)	(Per Cent)
All Areas	100.0	60.0	64.3	65.1	62.5	70.0	86.2
Area 1	100.0	59.2	58.6	58.1	58.8		71.2
Area 2	100.0	48.2	55.1	53.6	62.1	70.0	77.3
Area 3	100.0	82.1	86.7	91.5	96.7		79.1

It was found that, on the average, taxes absorbed 20.3 per cent of the net income of farm operators, and 28.9 per cent of the net rents. There is a tendency to tax small farms and large farms heavier than those of an intermediate size, although in many cases the additional tax burden on the small farms, when calculated on the average market value of such farms, is insignificant. However for large farms the difference in taxes appears to be significant.

FARM INCOME

This study was also carried on in coöperation with the United States Department of Agriculture and the North Carolina Tax Commission. A study was made of 1,156 owner-operated and 416 rented farms. A summary of the results is shown in Table X.

TABLE X.—Farm Business Summary of Owner-Operated Farms

1,156 farms (1927)

Areas	No. Farms	Acreage	Capital	Gross Receipts	Expenses	Farm Earnings	Family Labor	Operator's Income	Farmer's Labor	Net Income	Per cent return to Capital	5% Interest on Capital	Profits
Jackson	120	101	$4,050	$ 793	$ 269	$ 524	$ 68	$ 456	$ 613	$—157	—3.8	203	$—360
McDowell	64	141	5,347	1,016	431	585	67	518	699	—181	—3.4	267	—448
Ashe	97	138	7,730	1,158	590	568	64	504	749	—245	—3.2	387	—632
Mountain	281	123	5,616	964	410	554	67	487	679	—192	—3.4	281	—473
Catawba	99	103	6,973	1,552	595	957	125	832	880	—48	—0.7	349	—397
Davidson	121	92	6,114	1,383	489	894	117	777	870	—93	—1.5	306	—399
Person	91	139	7,559	2,970	1,048	1,922	197	1,725	939	786	10.4	378	408
Piedmont	311	109	6,810	1,894	679	1,215	143	1,072	894	178	2.6	341	—163
Moore Peach	41	335	26,053	14,804	8,604	6,200	73	6,127	1,286	4,841	18.6	1,303	3,538
Moore	51	129	6,156	2,398	1,256	1,142	100	1,042	705	337	5.5	308	29
Cumberland	108	141	8,569	2,859	1,607	1,252	140	1,112	812	300	3.5	428	—128
Lenoir	135	135	12,103	4,553	2,519	2,034	193	1,841	825	1,016	8.4	605	411
Costal Plain	335	160	11,765	4,933	2,776	2,157	147	2,010	859	1,151	9.7	588	559
Pender	134	166	5,473	1,809	953	856	85	771	664	107	2.0	274	—167
Chowan	95	127	10,332	3,598	1,836	1,762	155	1,607	931	676	6.5	517	159
Tidewater	229	150	7,489	2,557	1,316	1,241	114	1,127	775	352	4.7	374	—22
State	1,156	136	8,090	2,230	1,344	1,333	120	1,213	808	405	5.0	405	

Table X shows that in 1927 the average farm earnings were $1,333. These earnings were made on an average investment of $8,090. The highest earnings reported were $6,200, obtained by peach growers in the Moore area. The lowest farm earnings reported were obtained by farmers in the Mountain area and the highest in the Coastal Plain. For the Mountain region the average earnings for 281 farms were $554 per farm, as compared with $2,157

as the average earnings from 335 farms in the Coastal Plain. Farm earnings in the Piedmont region for 311 farms average $1,215, and the average earnings for 229 farms in the Tidewater were $1,241.

The average operator's income was $1,213. The highest operator's income was obtained by peach growers in the Moore area, and the lowest by farmers in the Jackson area. The average operator's income in the case of peach growers was $6,127, and for the farmers in the Jackson area the average was $456. The various regions ranked the same with respect to operator's income as they did in the case of farm earnings. In the Mountain region the operator's income of $487 is the lowest and $2,010 for the Coastal Plain is the highest. Tidewater ranks third with $1,127 and the Piedmont fourth with $1,072.

The average net income for the state was $405. It will be noted that this is equal to 5 per cent return on the average capital of $8,090, and, hence, as pointed out later, there were no profits. Net incomes in all of the Mountain areas and two of the three areas in the Piedmont were negative or minus. The lowest negative income, it will be noted, was $245 in the Ashe area and the highest positive income of $4,841 was obtained by Moore county peach growers. All in all, the average net incomes in the Mountain region were negative to the extent of $192 per farm. The highest regional net income was $859 per farm for the Coastal Plain. In the Piedmont the average was $178, and in the Tidewater $775.

According to this investigation the 1,156 farmers, on the average, did not receive profits. The average return to capital of $405 was just equal to 5 per cent return on the investment. In most areas returns to capital were less than a sum equal to 5 per cent on the capital invested and hence the profits were negative. This is true in the case of Jackson, McDowell, Ashe, Catawba, Davidson, Cumberland, and Pender areas. The only areas showing real profits were Person ($408); Moore (peach growers) ($3,538); Moore (non-peach growers) ($29); Lenoir ($411); and Chowan ($159).

The rate of return on capital invested for the state as a whole is exactly 5 per cent. For five of the eleven areas the rate of return was negative. the rates varied from—3.8 per cent in Jackson to 18.6 per cent in the Moore area (peach growers). Person County farmers made a return of 10.4 per cent, which together with Moore County (peach growers) were the only two groups with returns in excess of ten per cent.

In so far as returns are concerned, it is evident that farming in the Mountain region was on the whole unprofitable. The farm earnings, operator's income, net income, percentage of return on capital, and profits were all negative. Conditions in the Piedmont region appeared to be somewhat more favorable. Farm earnings and operator's income were fair, but net income and per cent return on capital were low, and profits were negative. In the Tidewater region conditions, as measured by the farm earnings and operator's income were similar to those in the Piedmont. Returns on investment were fair, but profits were negative. Conditions in the Coastal Plain were more satisfactory by far than in any other region of the State. Farm earnings and operator's income were each approximately 65 per cent higher than the average of all farms. The net income was reasonably high, per cent return on capital adequate, and profits while not high, were at least not negative.

Conditions in the various areas, as reflected by financial returns, are quite variable. Conditions were most satisfactory in Moore County (peach growers) and Lenoir, and the least satisfactory in the Jackson area. The income of the Moore County (peach growers) was probably somewhat higher than normal, as conditions in the peach industry were quite favorable in 1927. Lenoir area ranked next to Moore County (peach growers) with respect to farm earnings, operator's income, net income, and profits. With respect to per cent return on capital. Lenoir was outranked by Person County. On the other extreme was the Jackson area, where the operator's income, farm earnings, net income, per cent return on investment, and profits were all negative. Measured by financial returns, conditions in McDowell, Ashe, and Davidson were similar to those found in Jackson. In the Cumberland and Pender areas, while the conditions were not satisfactory, farm earnings and farm income were approximately the average for the state as a whole; per cent return on investment was low but positive, while profits were negative. Pender County agriculture was not profitable if the financial returns are taken as indices. In this area the farm earnings, net income, operator's income, per cent return on investment, and profits were all below the average. The showing made by the Moore County (non-peach growers) farmers was very similar to that of Cumberland, with the exception of the per cent return to capital. Profits, while positive in character, were very low. In the Chowan area conditions apparently were very similar to those in Person. This is especially true with respect to farm earnings, operator's income, and net income. Per cent return on capital was approximately 4 per cent lower, and profits approximately $241 less than in Person.

THE MARKETING OF COTTON

A study is being made of prices paid at eleven local cotton buying points in North Carolina, scattered to represent different conditions, in order to determine to what extent local prices take into account such factors as color, grade and staple length.

An arrangement is made with a local ginner at each point whereby the sales of individual bales may be traced and the price paid at the local point secured from the local buyer. Samples from these identical bales are sent to the United States Department of Agriculture for classing as to grade, staple, and color. It is then possible to make computations which will indicate whether the local price—grade for grade, staple for staple, and color for color—correspond with the price paid at terminal markets, after cost of transportation, handling and insurance to move the bale from local point to central point have been deducted.

Data for this study were collected for the year 1928 and the study will be continued through 1929. In 1928 approximately nine thousand prices were secured for computation, of which six thousand were single sales and three thousand were round lot sales of two or more bales.

Computations made on the basis of these prices indicate, among other things, (1) that buyer's spread in all places studied varied considerably within any combination of color, grade, and staple (2) that short staple cotton (shorter than 7/8") was being bought for more than the central market value and longer staple (15/16 inches and better) was being bought for less than its central market value, costs considered; (3) that the average

price paid for strict middling and good middling grades of white cotton was generally less than the central market price, costs considered, whereas the average price paid for strict low middling was generally greater.

During the ensuing year these price data will be subjected to further analysis.

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RESEARCH IN AGRONOMY

During the year the main efforts of the Agronomy Department have been expended in work on some of the more important problems in soil chemistry, soil fertility, crop rotation, plant breeding, crop improvement, cultural treatment and others involved in the economic production of crops. Much effort, too, has been given to the classification and mapping of soils occurring in the various counties of the state.

The major activity in soil chemistry research has been centered on the investigations of the magnesium supplies of representative sandy loam soils and factors governing the availability of that element. This has led to further attention in the study of the effect of liming such soils with dolomitic limestone as well as other forms of lime on manganese deficiency.

Field plat studies of the value of copper and manganese salts with lime and phosphate on a peat soil have been continued. The project dealing with the relation between soil factors and peach winterkilling has been discontinued.

A study of the injurious effect on cotton of some highly concentrated fertilizers when used on Norfolk sand has been undertaken.

Soil fertility experiments on different soil types of the same general nature, as mentioned in previous reports, have been continued on the central farm, at the six branch station farms and on twenty-three outlying fields with corn, cotton, peanuts, red clover, soybeans, mint, sweet potatoes, Irish potatoes, and sweet clover. All these investigations have been planned mainly to study the main plant food deficiencies of major soil types occurring in the state and to establish the best kinds and amounts of plant nutrients to use on each type of soil for best paying results. Some attention, too, is being given to a study of the relative value of different methods and times of applying fertilizers, with special reference to nitrogen. Since the cheapening of inorganic nitrogen, it has become necessary to use as large a proportion as possible from this source and to do so with the least loss from leaching. In order to use these largely, it will become necessary to divide the application, especially on sandy and other soils of a leachy nature. The object in some of the experiments is, therefore, to determine the best methods of application to follow in bringing about the greatest ultilization by crops of the total nitrogen derived from such forms. Since organic sources of nitrogen are generally very expensive, it makes their use in large quantities in fertilizer mixtures out of the question, except in especial cases and for certain crops.

The experiments being conducted for sometime by the Department to study the effects of crop rotation upon crop yields when grown under different fertilizer and lime treatments are being continued at the Coastal Plain, Piedmont and Mountain farms.

The work in classifying and mapping of the soils of the state, carried on in coöperation with the Federal Bureau of Chemistry and Soils, has been actively pushed during the year. During the summer, the men work in the western half of the state, while in the winter they are in the eastern half. Before leaving a county, a map is made of it, showing by different colors

the extent and boundries of each type of soil occurring in it. The report which it accompanies, when published, includes a description of each type of soil and gives much information on crops grown and the general practices being followed by farmers in the growth of these on each type of soil.

The research work in crop improvement has resulted in the production of many new strains and varieties of cotton, soybeans and corn, and in the introduction of others, after comparative field trials, of much value to farmers of the state. More recently, an especial effort has been directed towards the improvement of the quality of some of the major crops being grown in the state, especially of cotton and soybeans. Some effort, too, is being made to find a good-quality and high-yielding strain of cotton which will be resistant to wilt, this disease occurring in rather alarming proportions in certain counties of the state having very sandy soils.

SOIL SURVEY

North Carolina was one of the first states in the Union to take up in cooperation with the Federal Bureau of Chemistry and Soils a systematic classification and mapping of the soils of the state. This work was started in the State about thirty years ago, when a nine-mile strip from Raleigh to New Bern was surveyed and mapped. Since that time, by continuous effort, something like three-fourths of the total area of the state has been mapped and individual reports have been issued covering the agriculture and soils of each county in which the work has been completed. At present, four men—two Federal and two State—are spending their entire time in the field in this work.

During the year, Craven, Gates, Person and Watauga counties have been finished and work is well underway in Macon and Montgomery counties.

The soil type findings of the soil survey are being used as basic information, not only in planning and putting out much of the research work of the Department but also in making an application of its results to the practical needs of farms of the state.

Below is given some of the more specific information brought out by soil survey work in North Carolina.

PERCENTAGE OF SOIL SERIES BY PROVINCES

In the counties surveyed, the following have been found to be the percentages of the different soil areas in the various provinces of North Carolina:

I. IN COASTAL PLAIN:

Norfolk series	54.0 per cent
Portsmouth series	19.0 per cent
Coxville series	5.3 per cent
Ruston series	2.9 per cent
Bladen series	2.6 per cent
Hoffman series	2.5 per cent
Muck series	2.2 per cent

II. IN RIVER FLOOD PLAINS:

Swamp series	44.0 per cent
Congaree series	22.0 per cent
Meadow series	9.5 per cent
Ochlocknee series	4.6 per cent
Toxaway series	3.5 per cent

Wickham series	3.4 per cent
Kalmia series	3.0 per cent
Wehadkee series	1.9 per cent

III. IN PIEDMONT PLATEAU:

Cecil series	49.0 per cent
Georgeville series	14.0 per cent
Alamance series	7.8 per cent
Durham series	6.4 per cent
Iredell series	5.5 per cent
Appling series	4.4 per cent
Granville series	2.7 per cent
Wilkes series	2.3 per cent
Davidson series	1.5 per cent
White Store series	1.5 per cent

IV. IN APPALACHIAN MOUNTAINS AND PLATEAUS:

Porter's series	74.0 per cent
Ashe series	11.6 per cent
Chandler series	6.6 per cent
Talladega series	3.4 per cent
Rough stony land	2.7 per cent
Rock outcrop	0.8 per cent

IMPORTANT SOIL TYPES BY PROVINCES

Since soil type is an essential factor to be considered in planning and putting out Agronomy and other research work dealing with soils, the more important ones by provinces, in the order of their importance, are given in the following summations:

I. IN COASTAL PLAIN:

Norfolk fine sandy loam
Norfolk sandy loam
Norfolk sand
Norfolk fine sand
Portsmouth fine sandy loam
Portsmouth loam
Norfolk coarse sand
Hoffman sandy loam
Portsmouth sand
Portsmouth sandy loam
Muck
Coxville very fine sandy loam
Peat
Portsmouth fine sand
Coxville silt loam
Portsmouth silt loam
Dunbar very fine sandy loam
Coxville fine sandy loam
Ruston sandy loam
Ruston fine sandy loam
Portsmouth very fine sandy loam
Swamp
Bladen loam
Hyde loam

II. IN RIVER FLOOD PLAINS:

Swamp
Congaree silt loam
Meadow
Congaree fine sandy loam
Ochlocknee loam
Congaree silty clay loam
Wickham fine sandy loam
Toxaway loam
Wehadkee silt loam
Kalmia sandy loam
Toxaway fine sandy loam
Congaree loam
Kalmia fine sandy loam
Johnston silt loam
Johnston loam
Altavista very fine sandy loam
Altavista fine sandy loam
Bermudian loam
Roanoke loam
Toxaway clay loam
Altavista loam
Bermudian silty clay loam

III. IN PIEDMONT PLATEAU:

Cecil sandy loam
Cecil clay loam
Cecil clay
Alamance gravelly silt loam
Davidson clay loam
Cecil gravelly loam

Georgeville silt loam
Alamance silt loam
Cecil fine sandy loam
Durham sandy loam
Georgeville gravelly silt loam
Appling sandy loam
Cecil loam
Durham coarse sandy loam
Iredell loam
Georgeville silty clay loam
Cecil sandy clay loam
Wilkes sandy loam
Iredell fine sandy loam
Cecil coarse sandy loam
Iredell sandy loam
Durham fine sandy loam
Granville fine sandy loam
Alamance slate loam
Granville coarse sandy loam
Appling coarse sandy loam
White Store fine sandy loam
Louisa loam
Iredell clay loam
Granville sandy loam
Rough gullied loam
Conowingo silt loam
Louisa gravelly loam
Mecklenburg clay loam
White Store sandy loam

IV. IN APPALACHIAN MOUNTAINS AND PLATEAUS:

Porter's loam
Porter's sandy loam
Ashe loam
Porter's clay
Porter's stony loam
Chandler loam
Porter's black loam
Porter's sand
Rough stony land
Talladega clay loam
Porter's clay loam
Talladega loam
Rock outcrop
Ashe stony loam
Chandler stony loam
Burton stony loam
DeKalb stony loam
Talladega stony loam
Ashe very course sandy loam
Ashe sandy loam
Porter's fine sandy loam
Ashe fine sandy loam

PRINCIPAL SOIL TYPES BY COUNTIES

In mapping soils in the soil survey work, the following have been found to be of first, second and third importance in extent in the different counties of the state:

County	First in Importance	Second in Importance	Third in Importance
Alamance	Durham sandy loam	Georgeville silt loam	Davidson clay loam.
Alexander	Cecil sandy loam	Cecil clay loam	Porter's loam.
Alleghany	Ashe loam	Porter's loam	Toxaway loam.
Anson	Georgeville silt loam	Cecil gravelly loam	Norfolk sandy loam.
Ashe	Chandler loam	Ashe loam	Talladega clay loam.
Avery	Ashe loam	Porter's loam	Clifton loam.
Beaufort	Portsmouth loam	Dunbar fine sandy loam	Coxville very fine sandy loam.
Bertie	Dunbar fine sandy loam	Coxville fine sandy loam	Lufkin silt loam.
Bladen	Norfolk sandy loam	Norfolk sand	Portsmouth fine sandy loam.
Brunswick	Norfolk sand	Norfolk sandy loam	Coxville fine sandy loam.
Buncombe	Cecil clay loam	Porter's loam	Cecil sandy loam.
Burke	Cecil clay loam	Madison gravelly loam	Ashe loam.
Cabarrus	Cecil clay loam	Alamance silt loam	Cecil sandy loam.
Caldwell	Porter's loam	Cecil clay loam	Ashe loam.
Camden	Bladen silt loam	Elkton silt loam	Peat.
Carteret	Norfolk sandy loam	Portsmouth fine sandy loam	Norfolk sand.
Caswell	Cecil sandy loam	Durham sandy loam	Iredell loam.
Catawba	Cecil clay loam	Cecil sandy loam	Madison gravelly loam.
Chatham	Georgeville silt loam	Alamance silt loam	Granville sandy loam.
Cherokee	Porter's loam	Talladega loam	Congaree loam.
Chowan	Portsmouth sandy loam	Coxville fine sandy loam	Norfolk sand.
Clay	Porter's loam	Cecil clay loam	Talladega loam.
Cleveland	Cecil clay loam	Durham sandy loam	Cecil sandy loam.
Columbus	Norfolk sandy loam	Coxville fine sandy loam	Portsmouth fine sandy loam.
Craven	Portsmouth fine sandy loam	Coxville fine sandy loam	Norfolk sandy loam.
Cumberland	Norfolk sand	Ruston sandy loam	Hoffman sandy loam.
Currituck	Norfolk loamy fine sand	Elkton silt loam	Bladen silt loam.
Dare	Peat	Norfolk sand	Bladen loam.
Davidson	Georgeville silt loam	Cecil sandy loam	Durham sandy loam.
Davie	Cecil clay loam	Iredell loam	Appling sandy loam.
Duplin	Norfolk sandy loam	Norfolk sand	Portsmouth sandy loam.
Durham	White Store fine sandy loam	Georgeville silt loam	Durham sandy loam.

Edgecombe	Norfolk sandy loam	Norfolk sand	Portsmouth sandy loam.
Forsyth	Cecil clay loam	Cecil sandy loam	Appling sandy loam.
Franklin	Durham sandy loam	Cecil sandy loam	Appling sandy loam.
Gaston	Cecil sandy loam	Cecil clay loam	Louisa loam.
Gates	Coxville silt loam	Norfolk sand	Dunbar fine sandy loam.
Graham	Porter's loam	Talladega loam	Congaree fine sandy loam.
Granville	Durham sandy loam	Granville sandy loam	Alamance silt loam.
Greene	Norfolk sandy loam	Norfolk sand	Ruston sandy loam.
Guilford	Cecil clay loam	Wilkes sandy loam	Appling silt loam.
Halifax	Norfolk sandy loam	Ruston sandy loam	Cecil sandy loam.
Harnett	Norfolk sand	Ruston sandy loam	Norfolk sandy loam.
Haywood	Porter's loam	Cecil clay loam	Congaree fine sandy loam.
Henderson	Porter's loam	Cecil clay loam	Cecil sandy loam.
Hertford	Congaree fine sandy loam	Norfolk sandy loam	Portsmouth fine sandy loam.
Hoke	Norfolk sand	Norfolk sandy loam	Hoffman sandy loam.
Hyde	Muck	Hyde loam	Portsmouth fine sandy loam.
Iredell	Cecil clay loam	Cecil silt loam	Porter's loam.
Jackson	Porter's loam	Cecil clay loam	Congaree fine sandy loam.
Johnston	Norfolk sandy loam	Cecil sandy loam	Durham sandy loam.
Jones	Norfolk sandy loam	Coxville fine sandy loam	Norfolk sand.
Lee	Wadesboro fine sandy loam	Coxville fine sandy loam	Norfolk sand.
Lenoir	Norfolk sandy loam	Norfolk sand	Portsmouth fine sandy loam.
Lincoln	Cecil sandy loam	Cecil clay loam	Louisa loam.
McDowell	Cecil clay loam	Porter's loam	Congaree fine sandy loam.
Macon	Porter's loam	Cecil clay loam	Congaree fine sandy loam.
Madison	Porter's loam	Cecil clay loam	Habersham sandy loam.
Martin	Norfolk sandy loam	Coxville fine sandy loam	Lenoir fine sandy loam.
Mecklenburg	Cecil clay loam	Cecil sandy loam	Iredell loam.
Mitchell	Porter's loam	Clifton loam	Ashe loam.
Montgomery	Georgeville silt loam	Alamance silt loam	White Store fine sandy loam.
Moore	Norfolk sand	Hoffman sandy loam	Durham sandy loam.
Nash	Cecil sandy loam	Norfolk sandy loam	Durham sandy loam.
New Hanover	Norfolk sand	Portsmouth sand	Norfolk sandy loam.
Northampton	Norfolk sandy loam	Lufkin silt loam	Ruston silt loam.
Onslow	Norfolk sand	Portsmouth sandy loam	Norfolk sandy loam.
Orange	Georgeville silt loam	Davidson clay loam	Wilkes sandy loam.
Pamlico	Portsmouth fine sandy loam	Bladen loam	Norfolk fine sandy loam.

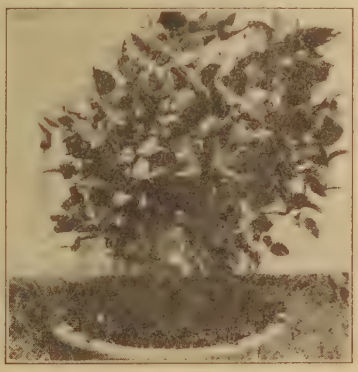
County	First in Importance	Second in Importance	Third in Importance
Pasquotank	Coxville fine sandy loam	Portsmouth fine sandy loam	Norfolk fine sandy loam.
Pender	Coxville fine sandy loam	Norfolk fine sandy loam	Portsmouth fine sandy loam.
Perquimans	Coxville fine sandy loam	Portsmouth fine sandy loam	Norfolk fine sandy loam.
Person	Georgeville silt loam	Alamance silt loam	Wilkes silt loam.
Pitt	Norfolk sandy loam	Portsmouth sandy loam	Coxville fine sandy loam.
Polk	Cecil clay loam	Porter's loam	Davidson clay loam.
Randolph	Georgeville silt loam	Alamance silt loam	Iredell loam.
Richmond	Norfolk sand	Georgeville silt loam	Cecil sandy loam.
Robeson	Norfolk sandy loam	Portsmouth sandy loam	Norfolk sand.
Rockingham	Cecil clay loam	Appling sandy loam	Wadesboro fine sandy loam.
Rowan	Cecil clay loam	Cecil sandy loam	Iredell loam.
Rutherford	Cecil clay loam	Porter's loam	Appling sandy loam.
Sampson	Norfolk sand	Norfolk sandy loam	Portsmouth fine sandy loam
Scotland	Norfolk sandy loam	Norfolk sand	Portsmouth fine sandy loam.
Stanly	Georgeville silt loam	Alamance silt loam	Davidson clay.
Stokes	Cecil clay loam	Cecil sandy loam	Wadesboro fine sand.
Surry	Cecil clay loam	Cecil sandy loam	Durham sandy loam.
Swain	Porter's loam	Cecil clay loam	Talladega loam.
Transylvania	Porter's loam	Cecil clay loam	Congaree fine sandy loam.
Tyrrell	Portsmouth fine sandy loam	Bladen fine sandy loam	Dunbar fine sandy loam.
Union	Alamance silt loam	Georgeville silt loam	Cecil clay loam.
Vance	Durham sandy loam	Cecil sandy loam	Appling sandy loam.
Wake	Cecil sandy loam	Durham sandy loam	White Store fine sandy loam.
Warren	Cecil sandy loam	Durham sandy loam	Cecil clay loam.
Washington	Bladen fine sandy loam	Portsmouth fine sandy loam	Dunbar fine sandy loam.
Watauga	Ashe loam	Porter's loam	Clifton loam.
Wayne	Norfolk sandy loam	Norfolk sand	Kalmia fine sandy loam.
Wilkes	Cecil clay loam	Porter's loam	Ashe loam.
Wilson	Norfolk sandy loam	Norfolk sand	Ruston fine sandy loam.
Yadkin	Cecil clay loam	Davidson clay loam	Cecil sandy loam.
Yancey	Porter's loam	Cecil clay loam	Ashe loam.

SPECIAL FERTILIZER AND SOIL FERTILITY PROBLEMS

Magnesium Deficiencies of Sandy Soil Types. Studies of the effect of liming with calcite and dolomite and of fertilization with potassium as the sulphate and chloride on the solubility of magnesium as well as other soil elements have been continued. The project which has now been carried on for two full years offers little evidence in the way of analytical data on which to base any conclusions.

The response of soybeans to the various combinations of treatments does however point to important limitations of these soils. This crop, which indicated the superiority of dolomite over calcite at both the one-ton and five-ton rates of application last year, gave a reversal with the one-ton rates of these materials this year. The young plants on all the calcite treatments

POT 8
Soybeans With Muriate of Potash



POT 36
Soybeans With Sulphate of Potash

POT 8. 1 ton calcite per acre—Muriate of potash.
POT 36. 1 ton calcite per acre—Sulphate of potash.

gave evidence of malnutrition similar to that attributable to magnesium deficiency but this was later outgrown in many instances.

There was a decided increase in yield on the limed over the unlimed Durham sandy loam at both rates of application of both calcite and dolomite but with the Norfolk sandy loam the one-ton rate was distinctly the better.

The most striking observation continues to be the superiority of sulphate of potash over the chloride. Not only are the plants larger in size but the foliage is a deeper green and there seems little reason to doubt that the difference is due to a deficiency of sulphur in these soils. This may be due to the excessive leaching of soils in containers but a pot culture test with corn conducted on a Norfolk fine sandy loam supports the conclusion that sulphur deficiency may be a matter of considerable importance.

The soil used was from a field experimental plat that has been unfertilized for over 20 years.

The original plan of the experiment provided for a study of the effect of potassium sulphate and chloride on the availability to plants and on the

solubility of the magnesium in the soil but this unforeseen sulphur deficiency has made the vegetation tests valueless for this purpose.

The limitations to the use of dolomitic limestone as a source of magnesium have been further studied by observation and experiment in the field and the importance of precision in the use of lime for any purpose has been established as regards some of the less well drained soils of the lower Coastal Plain. All crop plants except perhaps cotton and most weeds are limited in growth as a consequence of manganese deficiency on these soils when the reaction approaches neutrality.

Response of Corn to Sulphur on Norfolk Fine Sandy Loam

1. No sulphur ..... 22.0 grms. dry matter*
2. Calcium sulphate ..... 26.3 grms. dry matter
3. Sodium sulphate ..... 30.6 grms. dry matter
4. Potassium sulphate ..... 31.0 grms. dry matter

Ill effects from overliming other than those due to manganese deficiency have been observed and it is therefore not possible to offer any general recommendation for remedial treatments other than that liming, whether for the correction of soil acidity or for supplying magnesium, be done only in accordance with the reaction and tolerance of the soil.

Muck Soil Problems. Field plat experiments for studying the effect of copper and manganese salts in combination with lime and phosphate treatments have been continued but on a new field. An apparent lack of uniformity in the field where the first test was placed has raised a question as to the value of the first years' results.

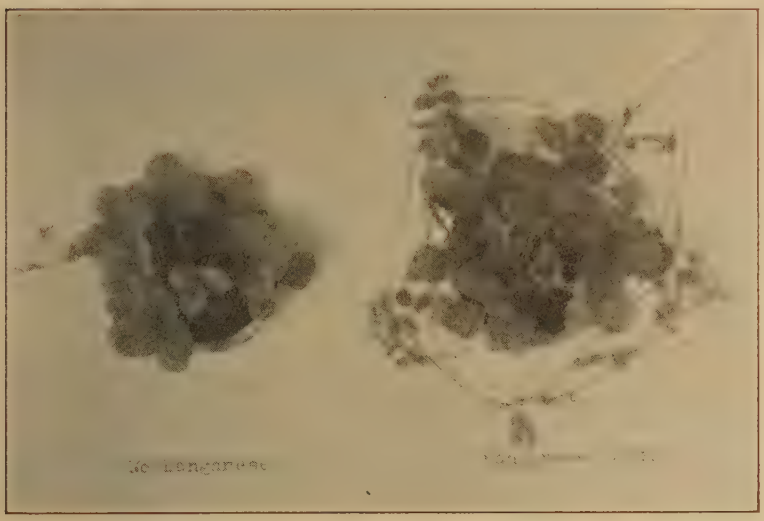
Concentrated Fertilizer Investigation. The failure of cotton on Norfolk sand when fertilized with a commercial high analysis fertilizer pointed to a problem of fundamental importance and pot culture tests have been conducted during the year to determine the cause of the trouble. The only

* Average of yields from 3 pots.

progress made has been in the direction of eliminating some of the hypotheses suggested by the results of field and pot culture experiments.

Strawberry Fertilizer Experiments. On account of the evident lack of uniformity of the soil on which the experiment was located, an attempt was made to determine the degree of variability for each treatment by dividing each 1/20-acre plat into 1/200-acre subplats as widely separated as as possible. The results have not been analyzed.

The early season was abnormally cold and wet and the quality and yield of berries was unsatisfactory over the entire field.



Strawberry Plants Grown on Alkaline Dunbar Fine Sandy Loam

As in past years, unproductive spots appeared in the field in which the plants were small and yellow. The reaction of the soil in these spots was found to be alkaline, apparently from the ash of fires made in clearing the land. Plants growing on adjacent soil of moderate acidity were normal in appearance.

This observation offers an explanation for the unsatisfactory results from the use of lime in a previous experiment which is supported by the occurrence of a chlorosis of soybeans indicative of alkalinity—induced manganese deficiency on the old strawberry field.

At the other extreme is the observation obtained from a simple pot culture experiment that an extremely acid soil on which strawberries would not grow was corrected by moderate liming.

Miscellaneous Services. The practice of analyzing liming materials for county agents and farmers has been continued as in the past and many soils have been tested, principally for reaction. This contact with the soil problems of the state has been of considerable value in pointing out some of the most pressing needs for investigation.

A large proportion of the soil samples which have been sent in for information as to the cause of unproductiveness have been found to be neutral or alkaline and the cause of the trouble has in many cases been one of the several that could be ascribed to the reaction.

SOME FIELD RESULTS IN SOIL FERTILITY STUDIES

AT COASTAL PLAIN BRANCH STATION (NORFOLK FINE SANDY LOAM)

Soil Fertility Experiment. This experiment was designed to study the main plant food requirements for corn, soybeans (for seed), and oats-and-vetch when grown in a three-year rotation on this type of soil. Nitrogen, phosphoric acid and potash were applied in varying amounts and ratios. All fertilizer treatments were carried on in duplicate, one series receiving 2,000 pounds of ground limestone every three years and the other none.

The use of lime has been found to decidedly increase the yield of both corn and soybeans, while for oats-and-vetch its use has not been profitable, except when no fertilizer was applied. The results given below show that a complete fertilizer containing nitrogen, phosphoric acid and potash is essential with this soil for all three crops.

Fertilizer	Average yield in bus. corn per acre (5 yrs.)		Average yield in lbs. oat-and-vetch hay per acre (4 yrs.)		Average yield in bus. soybeans per acre (2 yrs.)	
	Unlimed	Limed	Unlimed	Limed	Unlimed	Limed
NP	18.3	24.5	2235	2360	9.2	10.3
NK	24.5	32.6	2080	1845	8.6	12.3
PK	18.2	33.1	2160	2435	7.6	21.5
NPK	34.9	40.3	2955	2665	11.2	25.4
O	13.7	19.0	753	1508	2.7	7.9

While lime has increased the yield of soybeans, its use was associated with a chlorosis of the apical leaves of the plants. This malady has been shown to be due to a deficiency of manganese.

Soil Type Experiment. In this experiment, the same amount of nitrogen, phosphoric acid and potash has been added each year as is removed by the crop. A three-year rotation of corn, oats-and-vetch and soybeans (for seed) is followed. Although the use of lime has shown no marked effects on the yields of the crops, soybeans grown on the limed end have been chlorotic on all plats, except on the one on which Duplex basic slag was used instead of acid phosphate as a source of phosphoric acid. This slag contains manganese which has been shown to control this chlorosis.

AT UPPER COASTAL PLAIN BRANCH STATION (NORFOLK SANDY LOAM AND OKENEE FINE SANDY LOAM)

Fertilizer Ration and Quantity Experiment (Norfolk sandy loam). As an average of six years (1923-1928) results of continuous cotton grown on this field it has been found that as the percentage of phosphoric acid, using 800 pounds per acre of an 0-4-3 mixture was increased by two per cent increments from 6 to 12 per cent, the percentage of the total yield of seed cotton per acre opened at the first picking was gradually increased.

On an average of six years, the following were the percentages of the total crop opened at the first picking:

6-4-3—42.6 per cent
8-4-3—46.0 per cent
10-4-3—51.6 per cent
12-4-3—53.8 per cent

Using a 10-4-3 mixture on this soil in its present condition, as the quantity of fertilizer was increased by 200-pound increments from 400 pounds to 1,200 pounds per acre, the per cent of seed cotton opened at the first picking was decreased, the per cent opened at the first picking with 400 pounds being 60 per cent and the per cent opened at the first picking with 1,200 pounds being 45 per cent of the total yield.

It is interesting to note too with this soil which had been materially built up that without the use of fertilizers the per cent open at the first picking was greater than with any of the fertilizer combinations used. These observations with reference to the effects of fertilizers and quantity of fertilizers are contrary to many which have been made previously upon poor Cecil soils.

Sources of Nitrogen. This experiment was designed and put out to compare the relative efficiency of inorganic and organic sources of nitrogen, when used in a complete fertilizer. The average results obtained for the years 1927 and 1928 are presented in the following table:

Fertilizer			Lbs. seed cotton per acre-unlimed	Lbs. seed cotton per acre-limed	Lbs. seed cotton per acre-average
Ratio	Lbs. per acre	Source of nitrogen			
10-4-4	800	Nitrate of soda	1345	1173	1259
10-4-4	800	Leunasalpeter	1200	1135	1178
10-4-4	800	Urea	1285	1333	1309
10-4-4	800	Sulphate of ammonia	1305	1270	1288
10-4-4	800	½ Nit. soda, ½ sul. ammonia	1188	1370	1279
10-4-4	800	⅓ Nit. soda, ⅓ sul. ammonia, ⅓ c. s. meal	1210	1275	1243
10-4-4	800	½ Nit. soda, ½ c. s. meal	1243	1265	1254
10-4-4	800	½ Nit. soda, ½ fish scrap	1203	1025	1114
10-4-4	800	Cottonseed meal	1155	1080	1118
10 0-0	0		505	379	442

Inorganic nitrogenous materials when used as the sole source of nitrogen, as will be seen above, have given larger average yields than did the use of cottonseed meal as the source of nitrogen. Deriving the nitrogen from more than one source has not increased the yields above what was secured when the nitrogenous materials were used alone, except in the case of the cottonseed meal. Urea as the sole source of nitrogen has given the largest average yield. It has, however, been much easier to obtain a good stand on those plats receiving part or all of their nitrogen from an organic source. This has been found to be especially true during dry seasons, the soil solution during such seasons becoming more concentrated than the sap of the young seedling roots which has resulted in a collapse of the cell walls and death of many of the seedlings.

Time and Method of Fertilizer Application for Cotton (Norfolk sandy loam). This experiment was started in 1928 to determine the effect of time of application and placement upon the efficiency of the fertilizer as shown by its effect upon germination, stand, growth, and yield of seed cotton. Each treatment has been run in duplicate, with the fertilizer application at the rate of 1,000 pounds per acre of an 8-4-4 mixture. For series A, this mixture was made from 16 per cent superphosphate, muriate of potash and nitrate of soda. For series B, from superphosphate, muriate of potash, and 40 per cent of the nitrogen from nitrate of soda, 40 per cent from sulphate of ammonia, and 20 per cent from cottonseed meal.

Better stands of cotton have been secured on series B than on series A. However, when the seedlings were from two to three inches high, series A had a little better average growth. At maturity plants on plats with delayed nitrogen applications were smaller than those receiving nitrogen before or at planting time, although the stand was not so good. The average stand on plats receiving fertilizers ten days before planting and of divided applications were better than it was on those in which all the fertilizer was applied just before planting. Although less damage occurred to young seedlings from the use of large amounts of fertilizer in 1928 than in the two preceding years, the results point toward the advisability of either dividing the application or of making it at least ten days before planting. The most efficient of each of these methods will have to be determined by further investigation.

AT BLACKLAND BRANCH STATION (MUCK)

General Fertilizer Experiment. This experiment, designed to compare the different sources of phosphate and different fertilizer mixtures, has received limestone at the rate of 2,000 pounds per acre, applied broadcast every three years. It is run in a three-year rotation of corn; oats, soybeans for soil improvement; and Irish potatoes. It is divided into three series so that each crop is grown every year. Phosphate, used as either rock phosphate, superphosphate or basic slag, has not given substantial increases in yield as is shown by the six-year average results presented below.

Fertilizer	Source of phosphoric acid	Average yield corn bus. per acre	Average yield potatoes bus. per acre	Average yield oat hay lbs. per acre
NPK	Basic slag	44.0	140.1	4667
NP_2K	Rock phosphate	42.7	141.1	4820
NPK	Superphosphate	40.3	153.6	5457
NK		45.8	129.1	4725
NP	Superphosphate	15.5	53.0	3478
Stable manure		48.1	153.6	3788
O		18.1	60.5	3058

Normal fertilizer (NPK) was for corn and oats, 400 lbs. per acre of an 8-2½-4 mixture; and for Irish potatoes, 1,000 lbs. per acre of an 8-4-6. The plat receiving stable manure received it at the rate of 2,000 lbs. per acre for corn and oats, and 8,000 lbs. for Irish potatoes.

It is evident from these results that after liming, potash becomes the first limiting factor for crop growth on this soil.

Lime Experiment. This experiment was put out to determine the efficiency of different forms of lime, used every three years, when broadcast on muck soils in amounts varying from one to four tons per acre. As in previous years, slightly better results have been obtained from ground limestone than from equivalent amounts of either hydrated lime or marl. The use of lime in any form in all cases has resulted in materially increased yields. As an average of the results of 1917-1929, taking the yield from limestone as 100, the yields from hydrated lime and marl have been as follows:

With lime equivalent to the following CaCO3 application per acre every three years—

	2,000 lbs.	4,000 lbs.	6,000 lbs.	8,000 lbs.
Hydrated lime	86.9	98.7	92.0	97.1
Marl	70.2	92.0	88.8	94.8

Three hundred pounds per acre of an 8-2-4 fertilizer in addition to limestone increased the yields, but the use of fertilizer without lime was injurious. When the experiment was started twelve years ago, the response to fertilizers was negligible. However, response to its use appears to be increasing each succeeding year.

AT MOUNTAIN BRANCH STATION (TOXAWAY LOAM AND PORTER'S LOAM)

Soil Fertility Experiments. With soybeans for hay in 1928, in a three-year rotation of corn, wheat and soybeans on Field A, and using a normal amount of fertilizer (400 pounds of 12-2-4) the largest yield was obtained from the plat limed every four years at the rate of one ton per acre. Phosphoric acid omitted from the fertilizer decreased the yield more than by omitting either nitrogen or potash from the mixture. Omission of the potash has had least effect in decreasing yields.

On field B, with wheat for the crop in 1928, in a three-year rotation of Irish potatoes, wheat and soybeans, results have shown nitrogen to be the

main limiting factor on Toxaway loam, with phosphoric acid second in importance. For wheat Kainit proved a slightly better source of potash, followed by muriate of potash and sulphate of potash in order. All yields of wheat were affected by severe winter-killing. For Irish potatoes, the best source of potash was found to be muriate and for soybeans, kainit.

Study of Relative Value of Several Sources of Phosphoric Acid. In this experiment on Toxaway loam, wheat occupied the land for 1928. Superphosphate, finely ground rock phosphate, soft phosphate and Duplex basic slag were used respectively as the carriers of phosphoric acid. Comparisons were made on two series of plats, one limed and the other unlimed. When used in equivalent amounts, superphosphate and Duplex basic slag proved of equal value on the limed series, rock phosphate was second and soft phosphate the poorest source. On the unlimed series this same relative ranking was obtained.

The following were the results with the different carriers of phosphoric acid in a complete fertilizer:

Treatment	Source of phosphoric acid	Yield of wheat per acre-bus.	
		Limed	Unlimed
400 lbs. 7-3-1½	Superphosphate	22.0	21.3
400 lbs. 7-3-1½	Duplex basic slag	22.0	21.3
400 lbs. 7-3-1½	Rock phosphate	9.0	14.7
400 lbs. 7-3-1½	Soft phosphate	5.3	12.0

Crop Rotation Studies. This experiment is being conducted on Porter's loam (upland) soil. A study is being made of continuous cropping of corn and wheat in comparison with a two-year rotation of corn and wheat, grown without a legume for soil improvement and grown with a legume; and a three-year rotation of corn, wheat and red clover. Results with corn on the unlimed soil for 1928 showed a gain of 31.1 per cent in yield in the two-year rotation without a legume over continuous cropping and a gain of 114.4 per cent in favor of the two year rotation with a legume. Corn in the three-year rotation on unlimed soil gave an increase in yield of 142.8 per cent over this crop grown continuous on the same land, and an increase of 13.2 per cent over a two-year rotation with a legume. On limed soil, this crop in a two-year rotation without a legume showed an increase in yield of 30 per cent over when grown continuously on the same land, and in a two-year rotation with a legume a gain of 66.4 per cent over continuous cropping. This crop in a three-year rotation with a legume showed an increase of 66.9 per cent in yield over continuous cropping and a gain of 0.22 per cent over a two-year rotation with a legume.

Soil Type Studies. These studies consist of experiments in a four-year rotation of corn, oats, wheat and soybeans. Fertilizers are applied in amounts equal to that removed by maximum yields for each crop. On a portion of the plats, the nitrogen is supplied by crimson clover grown as a win-

ter cover crop. Yields for 1928 show the superiority of superphosphate over rock phosphate and the failure of the crimson clover to supply sufficient nitrogen for a good yield of the corn crop.

AT PIEDMONT BRANCH STATION (Cecil Clay Loam)

Soil Fertility Work. This work is being conducted to determine the chief plant food deficiencies of the Cecil soil series, and of finding the best proportions of fertilizing constituents for different crops adapted to the Piedmont region of the state. A four-year rotation is used on the fields as follows:

1st year—Cotton, rye.
2nd year—Corn, wheat (in fall).
3rd year—Wheat, red clover.
4th year—Red clover.

Work on two of the three fields has gone on without interruption but on the third field it was temporarily discontinued in 1923 and resumed in 1928. This interruption was made so that soil improvement crops might be grown to put the soil in better physical condition. Results for the past year are consistent with those of previous years. These show that phosphoric acid is the main limiting factor in the profitable production of corn, wheat and cotton, with nitrogen ranking second in importance. Potash is least required of the three main plant foods for this soil type. Lime, phosphoric acid and potash have been found necessary, however, to be supplied for the successful growth of red clover. Results with this crop in 1928 were a failure on the unlimed plats, except for those receiving liberal applications of phosphoric acid and potash. On the limed plats, applications of phosphoric acid gave greater yields than did either nitrogen or potash.

Superphosphate vs. Rock Phosphate. In this experiment, results for the past year continue to show that superphosphate is a more efficient carrier of phosphoric acid than rock phosphate when used in equivalent amounts under corn. This was especially noteworthy on the limed plats.

Nitrogen Carriers. This experiment is designed to compare the relative value of the more common sources of nitrogen in a complete fertilizer for cotton and corn grown in a two-year rotation. Results from cotton for 1928 show nitrate of soda best, followed in order by cottonseed meal, sulphate of ammonia, leunasalpeter, urea, calcium cyanamid, nitrate of ammonia and sludge.

Crop Rotation. The crop rotation work consists of a field study of the value of one-, two-, and three-year rotations with and without legumes (cowpeas, soybeans, and red clover), the fertilizer applications being the same with all rotations. Results with corn for 1928 on the unlimed soil have shown a gain of 48.6 per cent for the two-year rotation of corn and wheat without a legume grown for soil improvement over continuous cropping. In the two-year rotation with a legume grown for soil improvement corn showed a gain of 33.2 per cent over that grown in a two-year rotation without a legume. On the unlimed soil, this crop in a three-year rotation, with red clover occupying the land for the third year, gave an increased yield of 191.8 per cent over continuous cropping and an increase of 47.4 per cent over that grown in a two-year rotation with a legume.

On the limed soil, the corn in a two-year rotation without a legume gave an increase of 63.1 per cent over continuous cropping. In the two-year rotation with a legume it yielded an increase of 38.7 per cent over that grown in a two-year rotation without a legume. In the three-year rotation, using red clover, the corn gave an increase of 22.2 per cent over that grown in a two-year rotation with a legume.

AT CENTRAL STATION (CECIL CLAY AND SANDY LOAM)

Study of Proportions of Organic to Inorganic Nitrogen on Cotton. Three sources of inorganic nitrogen—nitrate of soda, sulphate of ammonia and leunasalpeter—were used in varying proportions with cottonseed meal as the organic source. In 1928, a proportion of 80 per cent nitrogen from nitrate of soda and 20 per cent from cottonseed meal as the sources of nitrogen in a complete fertilizer gave the highest yield of seed cotton with sulphate of ammonia a proportion of 25 per cent inorganic to 75 per cent organic gave the largest yield. Using leunasalpeter as the inorganic source, a ratio of 80 per cent inorganic to 20 per cent organic was best.

Source of Lime. In this experiment burnt lime, hydrated lime and ground limestone are applied every four years, at equivalent rates of one, two and four tons of calcium carbonate per acre. Soybeans for seed; rye, corn; oats-and-vetch (for hay), soybeans for seed; and cotton and crimson clover (for hay) are grown in a four-year rotation with soybean vines and rye used for soil improvement. All plats were fertilized with equivalent amounts of phosphoric acid from 16 per cent superphosphate but no nitrogen or potash was added. With cotton occupying the field in 1928, the highest yield was from an unlimed plat. Higher yields were obtained on plat using only one ton per acre of the three forms of lime, there being a progressive decline as the amounts of lime were increased. Cotton yields were low over the entire field and the crop showed striking evidence of potash deficiency.

Sources of Nitrogen. Nitrogen from seventeen different sources is used in making up complete fertilizers used in this field study. Cotton is grown continuously. The highest yield of seed cotton in 1928 was secured by a mixture of 75 per cent total nitrogen from nitrate of soda and 25 per cent from cottonseed meal, in a complete fertilizer. A mixture of 50 per cent of nitrogen from nitrate of soda and 50 per cent from nitrapo gave the second highest yield. Nitrapo and calcium nitrate ranked next, each yielding the same number of pounds of seed cotton. After these, in the order mentioned, came a mixture of 75 per cent total nitrogen from nitrate of soda and 25 per cent from calcium cyanamid; and leunasalpeter, calurea, urea, cottonseed meal, fish scrap, Kanona tankage, horn-and-hoof meal, calcium cyanamid, sludge, and digester tankage each as the sole source of the nitrogen supply.

AT TOBACCO BRANCH STATION (DURHAM SANDY LOAM)

All the research tobacco work in the state is conducted in coöperation with the Office of Tobacco Investigations of the U. S. Department of Agriculture.

The experimental work carried on at this station is largely with tobacco and crops relating to tobacco culture. The object is to improve the quality and yield of the cured tobacco in the flue-cured district. In order to better study these problems, the investigational work is subdivided into five divisions as follows:

(1) Fertilizer tests.
(2) Variety tests, selection and breeding.
(3) Burning tests or combustibility of the cured leaf.
(4) Curing.
(5) Crop rotation.

Fertilizer Experiments. Up to the present time, some work has been done on each phase of these investigations, but the major part of the work has been with fertilizers. These investigations consist of a large number of plats on which the different sources of nitrogen, phosphoric acid, and potash are being studied as well as various combinations and ratios of such sources of each of these constituents as seem to be best suited for the production of tobacco.

One series, consisting of 36 one-twentieth acre plats, has been carried on continuously since 1911. These plats are located in fields Nos. 1, 2 and 3. Tobacco is planted on them every year. The crops that are grown in rotation with tobacco on these fields are:

1st year—Tobacco.
2nd year—Winter oats for hay, followed by soybeans plowed under.
3rd year—Rye harvested for seed.

The land is then allowed to grow a crop of weeds which is fallowed in the fall preceding the tobacco crop. In 1920, these plats were divided, one-half of each plot was limed every third year preceding the tobacco crop with one ton per acre of dolomitic limestone applied broadcast. The initial application of limestone was made on field No. 1 in 1920. The fourth application was made on this field in 1929. The pH was determined on both series of plats in this field during the summer of 1929. The results showed that the limed plats were about neutral and on a few plats the pH was slightly above neutral, which is in the danger zone for the development of root rot (*Thielavia Basicola*), although there was no evidence of this trouble in the field during the 1929 season.

Results thus far secured show that about 80 pounds of phosphoric acid, 40 pounds of ammonia and 60 pounds of potash give the best returns. Mixed nitrogen has given better results than any of the individual sources. Superphosphate as the carrier of phosphoric acid was found to be more satisfactory than bone meal or basic slag. A mixture of potash with two units of the potash from muriate and the remainder from sulphate of potash, or sulphate of potash-magnesia gave better results than if all the potash was derived from either sulphate or muriate.

A number of other plats were used in testing the effect of chlorine, magnesium, calcium and sulphur on yield and quality of the leaf. The results clearly indicated that some chlorine is desirable, but the yield without injury to the combustibility of the cured leaf seemed to be best when only 20 to 25 pounds of chlorine per acre were added. Whenever a larger quan-

tity was added, there was no very definite increase in yield, and at the same time there was a decided injury to the combustibility of the leaf. On light sandy soils, the use of 40 to 50 pounds of chlorine per acre materially injured the growth of the plant producing a thick brittle leaf and in extreme cases a "cupping" up of the leaf.

The use of magnesia has been decidedly beneficial in the control of "sand-drown," and wherever sand-drown or magnesia hunger was evident, the addition of magnesia (MgO) gave decided increases in yield and quality. Magnesia derived from ground limestone has been every effective in correcting this deficiency and can be used advantageously so long as the soil is kept slightly acid. At the present time, it is deemed advisable that the pH reading should not be raised above 6.0 Sulphate of potash-magnesia may be used to supply magnesia with good results. The tobacco soils seem to be well supplied with calcium and sulphur by previous methods of fertilization.

Variety Tests. The work with varieties has been continued. With the assistance of James F. Bullock a number of individual selections have been made and are being tested out. Some of the strains of White Stem Orinoco and Cash show beneficial results from selections. A number of new strains of tobacco are being tested each year. A strain of Bonanza which was secured in Georgia shows considerable promise. A number of hybrids are being grown and selections are being made. None of these have been sufficiently standardized to place with the growers, but two or three of these hybrids are promising.

Burning Tests. These tests are made with tobacco receiving different fertilizer treatments. On plats receiving not more than 20 pounds of chlorine per acre the combustibility of the leaf is not injured, but as the chlorine above this quantity is increased the combustibility becomes poorer.

Curing. Some studies have been made with reference to different types of curing barns and the amount of fuel consumed. A hollow cinder block barn and a clay tile barn have been built on the station and compared with frame barns. The cinder block and clay tile barns are both very satisfactory with a comparatively low fuel consumption. On the other hand if a frame barn is well built, the sides being storm sheeted, papered and then weather-boarded tightly, there is not much difference in the fuel consumption of barns of this type and the concrete or clay tile barns, but the fire hazard is considerably less with concrete and clay tile barns than wooden ones. The cost of construction of barns from fire-proof material is higher than the wooden structures, but considering the upkeep and the reduction of the fire hazard it is not prohibitive.

Crop Rotation. Studies of crop rotations with tobacco have been continued. On soils that are low in organic matter, one legume crop during a three-year rotation has been found desirable. The rotation used in the regular fertilizer tests, viz: tobacco, oats, soybeans, and rye, has given excellent results. On soils infested with nematodes, causing root-knot, a variety of soybeans resistant to the nematode should be used.

FERTILIZER RESULTS ON SOIL TYPE FIELDS WITH FARMERS IN DIFFERENT PARTS OF THE STATE

On Ashe loam (Burke County). Results with corn for 1928 on this soil type conform to previous results in showing phosphoric acid to be the main limiting nutrient lacking for best crop yields. The beneficial effects of applications of lime were also shown.

On Appling sandy loam (Davie County). Results with cotton in 1928 conform to those of 1927. A higher yield of seed cotton was obtained when one-half of the total nitrogen was derived from an inorganic source (nitrate of soda) and one-half from an organic source (cottonseed meal) than when all came from an inorganic source. Nitrate of soda proved slightly better source of nitrogen than sulphate of ammonia. On this field, Trona muriate of potash has thus far proven to be a better source of potash than ordinary muriate and kainit.

The yields of seed cotton on this field in 1928 were as follows:

Fertilizer treatment per acre	Source of nitrogen	Yield seed cotton per acre
600 lbs. 10-5-3	Nitrate of soda	830
600 lbs. 10-5-3	½ nitrate of soda ½ cottonseed meal	1010
600 lbs. 10-5-3	Sulphate of ammonia	810
	Source of potash	
600 lbs. 10-5-3	Trona muriate of potash	910
600 lbs. 10-5-3	Muriate of potash	780
600 lbs. 10-5-3	Kainit	810

On Cecil clay loam (Mecklenburg County). Results with cotton on this type of soil in 1928 show that a 10-5-5 fertilizer mixture is probably the best proportion of the three main plant food constituents with a 600-pound application to cotton. Inorganic sources of nitrogen gave a larger yield of seed cotton than did organic sources, or combinations of organic and inorganic sources. For 1928, nitrophoska did not give as large yields as did equivalent amounts of phosphoric acid, nitrogen and potash from a commercial mixture.

First table on page 46 gives the results in 1928 on this field showing the comparative yields from different sources of nitrogen, and of nitrophoska as compared with a commercial mixture carrying the same amounts of phosphoric acid, nitrogen and potash per acre.

On Wilkes sandy loam (Guilford County) and Congaree silt loam (Watauga County. This work with Japanese mint was begun in 1928 in coöperation with the Vick Chemical Company of Greensboro, N. C., to develop an industry adaptable for small mountain areas. The best proportions of plant food constituents are being sought. Nothing conclusive was found from the 1928

study, aside from the decidedly beneficial effects of lime, in the growing of this crop. Apparently phosphoric acid is not a limiting factor. The relative values of nitrogen and potash are yet to be determined. The use of high percentages of potash has shown in the 1929 crop to greatly improve the growth of this crop on the Congaree silt loam.

Fertilizer treatment per acre	Source of nitrogen	Yield seed cotton per acre—lbs.
600 lbs. 10-5-3	Nitrate of soda	550
600 lbs. 10-5-3	Cottonseed meal	475
600 lbs. 10-5-3	⅔ nitrate of soda, ⅓ cottonseed meal	510
600 lbs. 10-5-3	⅓ nitrate of soda, ⅔ cottonseed meal	450
200 lbs. 32-16-16	Nitrophoska	570
800 lbs. 8-4-4	½ nitrate of soda, ½ cottonseed meal	610

On Norfolk sandy loam, low in organic matter, (Wayne County). Five years' average results on this soil using different sources of nitrogen in an 8-5-3 mixture are presented below.

Plot No.	Source of nitrogen	Average yield seed cotton per acre—lbs.
1	Nitrate of soda	1165
2	Sulphate of ammonia	1223
3	Cottonseed meal	1184
4	½ nitrate of soda; ½ cottonseed meal	1288
5	Nitrate of soda—½ at planting, ½ as side application	1407

It will be noted that sulphate of ammonia was more efficient on this soil than either cottonseed meal or nitrate of soda when used as the sole source of nitrogen. However, a mixture of nitrate of soda and cottonseed meal has given larger yields than has any single source of nitrogen. With nitrate of soda, dividing the application, one-half being applied before planting and one-half as a side application at the first cultivation of the cotton was the most profitable of all applications. By this method of application there was less injury to the young cotton seedlings.

Varying the phosphate in increments of two per cent from six to twelve per cent in a complete fertilizer was not attended in the heavier applications by any material increases over what was secured from six per cent. The yield of seed cotton was increased 400 pounds per acre by increasing the nitrogen in the mixture from 5 to 7 per cent. Varying the amounts of potash was less effective than was the case with nitrogen.

As the amount of fertilizer was increased from none to 900 pounds per acre, the yield of seed cotton was increased as indicated below.

There was considerable damage to young seedlings on the plat receiving 900 pounds of fertilizer per acre. This was especially true in 1926 and 1927, these seasons being very dry when the cotton had come up. Many of the seedlings died due to plasmolysis of the roots.

Formula	Fertilizer per acre	Average yield seed cotton per acre—lbs.
0-0-0	None	483
8-5-3	300	937
8-5-3	600	1165
8-5-3	900	1305

On Norfolk and Coxville fine sandy loams (Bertie and Hertford counties). Results thus far secured with peanuts on these soils indicate that the response to fertilization is largely dependent upon the fertilization of the preceding crop. Peanuts following corn have given good returns from the use of fertilizers, while those following cotton have made only slight increases from their use. A complete fertilizer analyzing 8 per cent phosphoric acid, 2 per cent nitrogen and 4 per cent potash applied at the rate of 400 pounds per acre has thus far given best results.

The use of gypsum has given best returns in dry years and is most effective when applied at the rate of 300 to 400 pounds per acre on the foliage at blooming time. The response to the use of lime has been found to depend largely upon the hydrogen-ion concentration of the soil.

SOIL FERTILITY FIELD EXPERIMENTS IN COOPERATION WITH FEDERAL BUREAU OF CHEMISTRY AND SOILS ON IMPORTANT SOIL TYPES

ON NORFOLK LOAMY FINE SAND (CURRITUCK COUNTY)

Fertilizer Ratio. Results thus far secured with Big Stem Jersey Sweet potatoes on three farms indicate strikingly that potato growers generally have not been using sufficient potash in their fertilizer mixtures. The use of 1,200 to 1,800 pounds per acre of a mixture containing 8 per cent phosphoric acid, 4 per cent nitrogen and 8 per cent potash has been found to be most profitable for potato growing for early market purposes.

Time and Method of Fertilizer Application. This experiment has been made to determine the best means of overcoming the injurious effects of large applications of fertilizer to young potato sprouts which frequently results on sandy soils. It is apparent from one year's results that a divided application of the fertilizer is going to be most efficient. The roots of the young sprouts growing on the heavily fertilized plats with all the fertilizer applied at planting were dwarfed and in most cases severely burned. To date the method of application does not seem to be as important as is the time of making the application.

Concentrated Fertilizers. The concentrated fertilizers tried out, as a whole, have not given as large returns as equivalent amounts of plant nutrients carried in ordinary commercial mixtures. However, the use of mixtures made from ammo-phos, potassium sulphate and either nitrate of soda, sulphate of ammonia, or urea have shown up very favorably. The average of two years' results, shows very little difference in the efficiency of these different nitrogenous materials when used in the above mixture.

On Cecil Clay loam (Central Station). In this experiment, four different fertilizers—two concentrated and two with equivalent amounts of plant food constituents from commercial mixtures—were applied to the soil in various manners, both 10 days before planting and at planting time. The purpose was to study the effects upon germination of the seed of the cotton. Results for 1928 have shown no pronounced injury to the stand on this soil from the concentrates, no matter how they were applied. The results further showed that the commercial mixtures gave a slightly increased yield over the concentrated mixtures, when used in equivalent amounts. This finding was verified by the results from a concentrated fertilizer experiment conducted in 1928 on a Cecil clay loam with cotton in Mecklenburg County.

On Cecil clay loam (Franklin County). This experiment was designed and put out to study the best ratio between inorganic and organic sources of nitrogen in a complete fertilizer for cotton grown on this type of soil. Nitrate of soda, sulphate of ammonia and leunasalpeter have been used as the inorganic sources. Results for the year 1928 show a ratio of 90 per cent nitrate of soda to 10 per cent cottonseed meal was best; 100 per cent total nitrogen from sulphate of ammonia gave a higher yield of seed cotton than any combination of sulphate of ammonia and cotton seed meal; while a ratio of 80 per cent leunasalpeter and 20 per cent cottonseed meal gave the highest yield in this series.

On Cecil Clay loam (Catawba County). This experiment was put out to show the best proportions, best sources, and best amounts of plant food to use in growing sweet potatoes on this soil type. All three plant foods were found necessary for highest and most profitable yields. Seven hundred and fifty pounds of an 8-4-4 and an 8-4-8 fertilizer have given larger yields than either 500 pounds or 1,000 pounds of the same mixtures.

Higher corresponding yields and profits were secured from the 8-4-8 mixture than from the 8-4-4 mixture.

Sulphate of ammonia and nitrate of soda proved of equal value as nitrogen sources, they outyielding all other sources. Inorganic sources of nitrogen made a yield of 270 bushels as compared with a yield of 253 bushels per acre from organic sources.

Muriate of potash, sulphate of potash, and kainit ranked in the order named as the best source of potash for sweet potatoes on this soil.

CROP IMPROVEMENT, CULTURAL WORK AND COTTON FIBER INVESTIGATIONS

COTTON IMPROVEMENT

The Mexican Big Boll variety is being grown on three of the branch station farms—Upper Coastal Plain, Central and Piedmont. Pure line selection work is being carried on at each of these farms and high yielding strains have been developed which are well adapted to the conditions under which they are grown. These strains are medium early, high yielders, and produce a staple of uniform length and high spinning quality.

The crop on the Upper Coastal Plain branch station was almost destroyed by a hail storm in 1928, but sufficient seed were saved from all strains to continue the work in 1929. Six strains, which vary somewhat in earliness.

are being grown with both high and low fertilizers in order to determine whether some strains respond more to high fertilization than do others. No results were secured in 1928 due to hail damage.

At the Central farm, pedigreed strain No. 6-1-9 is being grown for distribution. Strain No. 58, a selection from 6-1-9, has averaged 68 pounds of lint cotton per acre more than the parent strain over a two-year period and is more uniform in staple length. Seed of this strain will be available for distribution during the falls of 1929 and 1930.

Results of the strain test on the Piedmont station show the effect of mass selection vs. pure line selection and also the effect of change of climate and soil type on the yield and earliness of different strains.

STRAIN TEST, MEXICAN BIG BOLL COTTON—PIEDMONT FARM—1928

Strain	Yield of lint—lbs. per acre	Staple—in 32ds of inch	Per cent open—1st picking	Source of strains
Mexican No. 6 mass selected (3 yrs.)	357	33	71	Piedmont farm.
Strain No. 58-14	461	36	70	Central farm.
Strain No. 128	335	34	59	Central farm.
Strain No. 113	360	36	64	Central farm.
Strain No. 87-6	226	34	57	Upper Coastal Plain farm.
Strain No. 10-7	302	36	61	Upper Coastal Plain farm.
Strain No. 26-4	305	34	59	Upper Coastal Plain farm.
Strain No. 6-1-9(ck)	360	34	62	Central farm.

The mass selected seed have been grown on the Piedmont farm for several years and have become well acclimated, while the other strains were brought from the Central and Upper Coastal Plain station farms. The yield has been kept up by mass selections, but the staple has become shorter and is more irregular than from pure line selections. Strains Nos. 87-6 and 26-4 were brought from the Upper Coastal Plain branch station farm. This farm is located on Norfolk sandy loam soil and has an elevation of about 80 feet, while the Piedmont farm is located on Cecil clay and sandy loam and has an elevation of about 975 feet. The Central Station is on Cecil clay and sandy loam soil with an elevation of about 390 feet. The latitude of all three stations is about the same. Strains Nos. 87-6, 10-7 and 26-4 were high yielders at the Upper Coastal Plain branch station but when carried to a higher altitude and a different soil type yielded much less than strains from the Piedmont and Central farms.

The Mexican variety has been bred by the Experiment Station for more than ten years, pure line methods having been followed almost exclusively. No precautions have been taken to prevent cross-pollination in the plant-to-row and strain comparison plats, but the amount of cross-pollination has been rather small under normal conditions. Crosses between some of these strains are being made for the purpose of increasing the fruiting vigor, if possible. These strains are quite similar in plant and boll type and staple length. It should therefore be less difficult to develop a hybrid which would breed true than if the parents possessed quite different characters.

Inheritance Studies with Cotton. Work has been in progress during the past three years to determine the manner in which the fuzzy-tip character of cotton seed is inherited. This condition is found in upland cotton, being quite common in certain varieties. It is characteristic of certain strains of Sea Island and Pima cottons. The seed are smooth or nearly so except for a tuft of fuzz at the tip end of the seed. The amount of fuzz on the tip varies from a very small patch of short fuzz at the extreme tip of the seed to a heavy tuft of long fuzz which covers the entire tip and extends over about one-fourth of the length of the seed.

A strain homozygous for the fuzzy-tip or tufted character was isolated. This strain was crossed on a strain homozygous for the naked or smooth-seeded condition in 1926, and also on a strain homozygous for the entirely fuzzy condition. The F_1 generation was grown in 1927.

Cross: Fuzzy tip x smooth.
F_1 generation: All plants produced smooth seed and relatively high lint percentages.

SEGREGATION IN THE F_2 GENERATION

	Smooth seed, low lint (ave. 20 per cent)	Smooth seed, relatively high lint. (Av. 28 per cent)	Fuzzy-tip seed, high lint. (ave. 31 per cent)	Fuzzy seed, high lint. (ave. 32 per cent)
Observed No. of plants	58	119	45	21
Calculated No. of plants	60.7	121.5	45.6	15.2
Observed ratio	3.82	7.84	2.96	1.38
Calculated ratio	4	8	3	1

This and previous work indicates that the factor (S) which produces the smooth condition of the seed coat is dominant to the factor (s) which produces fuzz. The fuzzy-tip factor (T) is dominant to complete fuzziness (t) but is hidden in the presence of the factor (S). This data suggests the following genetic constitution of the parents. Smooth seeded parent SStt. Fuzzy-tip parent ssTT.

Cross: Fuzzy-Tip x Fuzzy. The seed of the F_1 plants were all fuzzy-tipped. In the F_2 generation, 21 plants produced fuzzy-tipped seed and 20 plants fuzzy seed. Less fuzz is apparently dominant to more fuzz, but the number of plants secured in the F_2 generation was not large enough to draw any conclusion as to the factors involved. The F_3 generation of these crosses is being grown in 1929.

Cotton Varieties. Experiments were conducted at four points in the State during 1928. The best varieties from the breeders, with many local varieties, were included in these experiments. The largest yields were secured from Mexican, Cleveland Nos. 884, 5, 20 and Carolina Foster in the 1 to 1⅛ inch class, and Wannamaker Cleveland in the 15/16 inch class. The varieties producing 1 to 1-1/16 inch staple gave the greatest money returns per acre. The varieties having light foliage, such as Carolina Foaster, are well adapted to the heavy soils of the lower Coastal Plain.

Variety experiments on wilt infested soils have thus far shown Dixie Triumph and Cook to be most resistant, followed by lightning Express, Super-Seven and Mexican. The Cleveland varieties were very susceptible to this disease.

SOYBEAN IMPROVEMENT

Soybean Varieties. Soybean variety experiments were conducted on the Central Station and at the Coastal Plain, Blackland, Piedmont and Mountain branch station farms. A large number of new introductions are grown each year on the Central station and Coastal Plain branch station farms in addition to the varieties commonly grown in the state. The new introductions, showing promise, are included in tests on the other branch stations. At the Coastal Plain branch station farm, the varieties leading in seed production over a four-year period were Herman, Tokyo, and Mammoth Yellow in the order named. The varieties leading in the production of hay were Otootan, Tokyo, Laredo, Herman, Mammoth Yellow and Biloxi. The best quality of hay was produced by the Otootan and Laredo varieties. The Herman and Tokyo varieties have been found to produce a better quality of hay than the Mammoth Yellow and Biloxi varieties. The Chiquita and Virginia produce a fine quality of hay but the yield is not as good as secured from the above varieties. At the Central station farm, Tokyo, Herman and Virginia were the best seed producers; while the best hay yields were secured from Otootan, Laredo, Herman and Chiquita over a period of six years. The Herman, Southern Prolific and George Washington were the best seed producers at the Mountain branch station. The best hay varieties were found to be Laredo, Herman and Virginia at this farm. The George Washington is medium early, non-shattering and very promising for the Piedmont and Mountain sections of the state.

Soybean Breeding. A number of yellow-seeded hybrids were found in the Biloxi variety and by plant-to-row selections made for a number of years, strains have been developed which are breeding true for seed color, plant type and non-shattering characteristics. The seed are of straw yellow and the foliage and pods are similar to Biloxi and are non-shattering.

SMALL GRAIN IMPROVEMENT

Small Grains for Forage and Cover Crops. Abruzzi rye, Tennessee hooded barley, and two varieties of oats were seeded on the Coastal Plain and Blackland branch station farms during the fall of 1928. No winter-killing was observed on either farm during the past winter.

Abruzzi rye made the best winter and early spring growth, and also the best growth for turning under by April 1. Oats made an earlier spring growth than barley, but were not equal to rye for grazing and cover-crop purposes.

Barley was almost a total failure on both farms during the two years it has been tried. The growth was very poor, it being usually about 12 to 16 inches high. A large percentage of the culms did not head out and most of the heads produced were poorly filled. Barley is apparently less tolerant of poorly drained soils than is either rye or oats.

While Abruzzi rye made a much larger growth up to April 1, the total growth was less than secured from Lee oats.

The yields of hay secured were as follows:

Crop and variety	Yield of hay per acre—pounds	
	Coastal Plain Station	Blackland Station
Fulghum oats	1800	2330
Lee oats	2580	3790
Tennessee barley No. 6	790	990
Abruzzi rye	2060	2370

Vetch Varieties and Austrian Peas. Three varieties of vetch and two sources of hairy vetch seed, and Austrian peas were seeded with oats on the Coastal Plain farm during October, 1928. The yields of hay were as follows:

Crop and Variety	Yield of hay per acre—pounds
Oregon vetch and oats	2630
Hungarian vetch and oats	2040
Hairy vetch (imported) and oats	2350
Hairy vetch (American grown) and oats	2540
Austrian peas and oats	2560

Hungarian vetch made only about one-half the growth secured from the other vetches. Imported hairy vetch made nearly as good growth as was secured from American-grown seed but contained a considerable amount of mixture of smooth vetch.

Austrian peas made equally as good growth as hairy vetch.

PEANUT IMPROVEMENT

Selection work for higher yields and better quality has been started with the Virginia Bunch and Jumbo Runner varieties. These are the leading varieties planted in the principal peanut-producing area of the state. They are, too, the best yielders of the large types of peanuts.

Peanut Spacing. Experiments to determine the best distance for spacing the plants in three-foot rows were begun in 1929. The hills were spaced 4, 8, 12 and 16 inches apart in the row with both 1 and 2 plants to the hill for this study. The Virginia Bunch and Jumbo Runner varieties are each being used.

RESULTS OF WORK WITH CEREALS

Corn. The improvement of different varieties grown on the branch station farms by seed selection has been continued. The accumulated effect of continued selection is the most that has been accomplished for the past season. Two very promising strains of Weekley's Improved have been developed on the Piedmont and Tobacco branch station farms. They have shown up well in variety tests. Cocke's Prolific is being improved on both the Cen-

tral and Coastal Plain farms. Considerable improvement can be noted without anything outstanding having been accomplished as yet. A selection for two ears to the stalk has been made on the Mountain farm from the old Biggs' seven-ear variety. A most desirable strain in all particulars except the essential one of yield has been developed. In yield it is not measuring up to the high standard desired. Selection is to be continued with this one object in view. Latham's Double, the very high yielding variety grown in the Coastal Plain area, is being improved on the Upper Coastal Plain branch station farm. The selections on this farm for the past season have not yet been harvested but observation of the results in the field show them to be unusually promising. In a test of adaptable varieties, Highland Horsetooth, a variety developed by D. W. Bagley of Currituck county, was judged the most suitable variety for the soil of the Blackland branch station. Selections have been made from it on this farm for the past two seasons.

Wheat. The most outstanding result of the wheat work for the past season was the establishment of a standard of yields by which all new varieties or strains that are proposed to be grown by the farmers of the state can be measured for yielding qualities. The average results for a seven-year period are as follows for the four leading varieties:

Variety	*Average Yield bushels per acre*
Fulcaster	29.2
Gleason	28.4
Purple Straw	27.2
Leap's Prolific	27.0

At a glance, it can be seen that this list includes a late maturing bearded variety (Fulcaster), two late maturing smooth varieties (Gleason and Leap's Prolific), and one early maturing smooth variety (Purple Straw). These varieties represent the types of wheat grown throughout the state—early and late, bearded and smooth. A test of these varieties are to be continued in comparative tests from year to year with new varieties or strains.

Nittany, a new variety developed by the Pennsylvania Experiment Station by selection from Fulcaster, was carried in these tests for six consecutive seasons. It averaged 29.6 bushels per acre, while the nearest to it in yield was made by Fulcaster with a yield of 28.6 bushels.

Selection work with small grains has been started at the Piedmont branch station farm, being made possible by the purchase of a rod-row thrasher and a nursery-row thrasher. As a beginning, between 1200 and 1400 head selections for planting in nursery rows have been made for seeding during the fall of 1929. The selections include wheat and rye and a few of oats. This improvement work both by selection and hybridization is to be pushed in the future.

With the aid of machinery for thrashing small batches of grain without mixing, it is planned to grow in small quantities pure strains of the leading varieties of wheat and other small grains so that farmers who should be interested in growing a pure unmixed variety might have a source of pure seed for a beginning. It is proposed to have them free not only from mixtures of other varieties but from abnormal types of the same variety.

Rye. Rye tests of five years were discontinued on the Piedmont farm with the season of 1927. The Abruzzi variety leads the common rye in average yields by four and a half bushels per acre. The only rye tests now being conducted is on the Mountain farm in which common and Rosen rye are being compared. The past season was the first of the test and there was a slight difference in yield in favor of the Rosen. Prior to this time, there had been some selections of Abruzzi rye made on the Central station farm. These selections were carried in rod rows over a series of years, each season the less promising being rejected. The final selection was turned over to the farm and the past season saw the first general crop grown from this selection. It was so successful, the farm manager reports, that the field inspector of the Pure Seed Service of the State requested every pound of it he had to spare for propagation purposes.

Oats. The first problem in growing fall-sown oats is to find that variety which will withstand the changeable winter weather conditions of the Piedmont and Coastal Plain regions of the state. Fulghum and Appler are most excellent winter varieties, but are very easily winter-killed. In tests conducted for six years on the Piedmont farm the Fulghum, one of the best yielders, winter-killed about one-half. The above varieties are being grown in comparative tests at the Piedmont farm with cold resistent varieties like Norton, Lee, V.P.I. and others to determine which will produce the greatest average yield.

A series of comparative tests are now being conducted on the Mountain farm to determine which spring variety is best adapted to mountain conditions. There is a notion prevalent among the farmers of this section of the state that such winter varieties as Fulghum, Appler, and Norton will, if sown early in the spring, outyield strictly spring varieties like Burt and Richland.

On the Piedmont farm in coöperation with the Office of Cereal Investigations of the U. S. Department of Agriculture, a strictly cold resistant test was undertaken during the past season. The scheme is to plant 100 seed of the variety to be tested in rows one-foot wide with each plant two inches apart. A count is made in the fall after the seed have completely germinated and again in the spring after all danger of freezing has passed. Thus the per cent of winter-killing is determined. Along with the varieties supplied some local and other varieties are included for comparative purposes. Unfortunately for the test, there was no winter-killing during the past winter on account of its mildness. The test is to be continued during the coming winter.

A variety test for cold resistance and yield of hay was initiated on the Coastal Plain branch station farm during the past season. Here there was no winter-killing. The results in yields of hay are given below for this latter test.

Rank	*Varieties*	*Yields per acre Pounds of hay*
1	Lee	4,000
2	Norton	3,600
3	Appler	3,420
4	V.P.I.	3,240
5	Virginia Turf	3,100
6	Fulghum	2,900

This project has been enlarged and will be continued during the coming year.

COTTON FIBER INVESTIGATIONS

The greater part of the fall was spent in helping with the North Carolina Cotton Grade and Staple Estimate in coöperation with the Bureau of Agricultural Economics of the U. S. Department of Agriculture. Reports on this project are given by the Bureau of Agricultural Economics of the U. S. Department of Agriculture, and the Department of Agricultural Economics of the N. C. Agricultural Experiment Station. This project is closely related to research of the physical properties of the cotton fiber, and because of the relation it was deemed advisable to spend some time in traveling over the state to make contracts with ginners and farmers and thus secure direct information in regard to the type of cotton grown and of marketing problems.

Studies of the physical properties of cotton fibers were made in the laboratory. Several projects are receiving attention. None has been completed but considerable data have been obtained. A progress report on each project is given below.

(1 A stuty of fiber diameter or "fineness" is being made in order to find out if there is a difference in the diameter of fibers from strains and varieties having the same length of staple.

Measurements of fiber diameter were made of several leading varieties. The diameter was obtained by using both green and dry mercerized fibers. The results showed that fibers from varieties having a longer staple length were smaller in diameter.

A study of the data secured from the strains and varieties indicates a general tendency for an increasing length to be associated with a decreasing diameter and vice versa. This project is being continued.

The diameter of the fiber of numerous varieties and strains will be measured, for it appears that "fineness" in cotton of the same length might be due in some instances to differences in the original cell diameter.

The relation of "fineness" and thickness of fiber wall seems to be very important. Some observations have been made, and definite studies will be made along such lines.

(2) The uniformity and length of staple from pure strains of Mexican grown at the N. C. Agricultural Experiment Station in 1928 was measured on a mechanical sorter. The average length, modal length, uniformity and per cent of waste from each strain was accurately measured. Strains, having a poor staple, were discarded. It is planned to use the sorter in future seasons in order to aid in the cotton breeding program. Perhaps poor strains can be more quickly eliminated by making measurements which are more accurate than those being made by the ordinary hand stapling method.

(3) Further studies concerning the relation of drag and other fiber properties to yarn quality are being made in coöperation with the Bureau of Agricultural Economics of the U. S. Department of Agriculture. Two lots of cotton, showing contrast in drag, were spun into yarns by H. H. Willis, Senior Cotton Technologist, Clemson College, S. C. The physical properties of fibers from the cottons are being measured and all of the data will be assembled as soon as possible. No definite report can be made at this time.

(4) The effect of fertilizers on the physical properties of the cotton fiber is being investigated each season. This project was started in 1927. Data for two years would be unreliable, therefore no report is being given at this time.

C. B. WILLIAMS,
Head Department of Agronomy

RESEARCH IN ANIMAL HUSBANDRY

BEEF CATTLE, SHEEP AND SWINE INVESTIGATIONS

EARL H. HOSTETLER, in Charge

The research work with beef cattle, sheep and swine has continued along the same lines as was reported last year and the data from the different projects have yielded valuable information on some of the problems that are confronting animal husbandmen in the State.

There has been some improvement in the physical equipment both at the Central and Branch Stations and small increases have also been made in the herds and flocks.

BEEF CATTLE PROJECTS

1. Quality of Meat (Blackland Station, Wenona).

This work is a part of the national project on "The Quality and Palatability of Meat" and is being studied coöperatively with the U. S. Department of Agriculture, Bureau of Animal Industry and other State Experiment Stations.

Group of calves from purebred Hereford bull

The herd of native cows has been divided into two equal groups, with one group being bred to a pure bred Hereford bull and the other to a native or scrub bull of similar ancestry to the cows. The calves produced by these bulls were full fed a ration of shelled corn, cottonseed meal and soybean hay, and this first year's results show that the calves from the Hereford bull, during a 170 day fattening period, consumed 479 pounds of grain and 408 pounds of hay for each 100 pounds of gain, made an average daily gain

of 1.81 pounds, and sold for $12.50 per hundred weight; while the calves from the native bull consumed 543 pounds of grain and 441 pounds of hay for each 100 pounds of gain, made an average daily gain of 1.48 pounds and sold for $11.79 per hundred weight. The grade calves were also heavier and carried more finish when shipped to market, their average final weight being 631 pounds while the calves from the native bull averaged only 534 pounds in weight at this time.

2. Pasture Value of Native Reeds (Blackland Station, Wenona).

There is a dense reed growth (Arundinaria Tecta) covering many acres of land in the eastern section of North Carolina. This growth is especially profuse in the vicinity of the Blackland Station and is used as a pasture for both cattle and work stock.

Last year approximately 150 acres of this reed growth furnished abundant grazing for 29 native cows and two bulls from June 8 to January 1, and in addition, 27 of the cows suckled calves for six months of this period. During the seven months grazing period the 29 cows made an average gain of 67.0 pounds.

3. Comparison of Carbonaceous Roughages (Piedmont Branch Station, Statesville).

Twenty-six grade steers were purchased in Madison County, North Carolina, and shipped to the Piedmont Branch Station for fattening. They were divided into two equal groups and full fed for 136 days. Each group received equal parts of shelled corn and cottonseed meal as their grain ration, but cottonseed hulls furnished the roughage for Group 1 while in Group 2 corn stover was fed.

The steers in Group 1 required 57 pounds less corn and 57 pounds less cottonseed meal to produce 100 pounds gain than those in Group 2. They also consumed slightly less roughage, but possibly these results are not as indicative as they should be because of the fact that the corn stover was of rather poor quality.

4. Cost of Producing Beef (Central Station, Raleigh).

Records were kept on two grade Angus steers that were purchased for classroom work. No charge was made for pasture but the purchase price, as well as the cost of the other feeds consumed, was deducted from the sale price when these steers were slaughtered, showing a net profit of $20.86.

5. Vitamin A Studies (Central Station Farm).

(In Coöperation with Dr. J. O. Halverson)

This work was inaugurated in the fall of 1928 with six grade Shorthorn yearling steers, averaging 710 pounds in weight, to ascertain if there is a shortage of Vitamin A in a ration composed largely of cottonseed meal. These animals were purchased off grass in Western North Carolina and arrived at the Station October 12. From this time until January 8, 1929 they were fed slightly more than a maintenance ration of shelled corn and legume hay.

Five steers were started on the experimental ration, consisting of cottonseed meal, cottonseed hulls, beet pulp and mineral, on January 8 and were continued on this ration until they either died or went completely off feed. The sixth steer was slaughtered as a control on January 23.

All five of the steers receiving the experimental ration appeared to be healthy and vigorous and made good gains until April 30, but when the weights were taken on this date there was a decided decrease in the gains as compared with those taken 28 days earlier. They not only failed to gain after this time but began to lose weight and by June 30 two of the steers had died, another was in a serious condition, and the other two were swollen and emaciated. Post mortem examination of the animals that died showed an extreme oedematos condition, particularly around the joints and in the region of the flanks and brisket.

Animal No. 1 (left) and 3 (right) after 4½ months on restricted cottonseed meal ration

SHEEP PROJECTS

1. The Control of Stomach Worms in Lambs by Sanitation (Central Station, Raleigh).

This work was fashioned after the McLean County System of Controlling Worms in Pigs and was planned so as to determine the practicability of controlling stomach worm infestation in lambs by sanitary measures.

Twenty-four representative ewes from the Experiment Station flock were selected for this work on January 23, 1929. They were divided into three equal groups of eight ewes each. Group 1 served as the check lot and received no special treatment other than that expected in good sheep husbandry. Group 2 was cared for identically as Group 1 but the lambs are to be drenched for stomach worms with a nicotine sulphate solution at 28 day intervals (weigh days) from June 12 to October 2. Group 3 was separated from the general flock, placed in quarters that had not been used by sheep, and given the sanitation precautions as outlined under the McLean County System.

The stomach worm season was not far enough advanced by June 30, 1929 to note any difference between the lambs in the three groups. However, all

the ewes lambed except one in Group 2 and one in Group 3, and on June 30 there were eight lambs in each group.

2. Upgrading of Native Eastern North Carolina Sheep (Central Station, Raleigh).

The first year's results of breeding a pure bred Shropshire ram to six native Eastern North Carolina ewes was reported in last year's annual report. This year's results bring out still more forcibly the improvement brought about, since data were obtainable on the yearling half-breeds as well as the ewes and their lambs. At shearing time, May 2 to 6, the average sheared weight of the old ewes was 75.33 pounds, and their fleece 3.12 pounds with an average length of 2.42 inches, while the average sheared weight of the yearling half-breed ewes was 92 pounds, and their fleece 6.83 pounds with an average length of 3.83 inches. The five lambs, which were about three months old averaged 46 pounds. There was equally as much improvement in conformation as there was in size and fleece.

Native ewe with yearling and lamb sired by Shropshire ram

3. Drenching Lambs for Stomach Worms (Piedmont Branch Station, Statesvile, and Central Station, Raleigh).

In this experiment ten lambs at both farms were divided into two equal groups of five lambs each. At each place one group was drenched with a nicotine sulphate solution at 28 day intervals from May until October. The other groups ran with the drenched lambs but received no treatment. All lambs were weighed at 28 day intervals, and post mortem examinations for stomach worms were made of representative animals before the experiment started and of the animals that died during the trial.

For the first two months the lambs in the undrenched group at Statesville gained the most and for the first three months the ones in the undrenched group at Raleigh gained the most, but after these weigh days there was a decided advantage in favor of the drenched groups. The lambs at Raleigh were on temporary pasture while those at Statesville were on permanent pasture which probably accounts for the early stomach worm infestation at the latter farm. All of the lambs died in the undrenched group at Raleigh and all but two in the undrenched group at Statesville, and were found to be heavily infested with stomach worms. All lambs in the drenched groups showed gains at the close of the experiment.

4. **Wintering the Farm Flock** (Central Station, Raleigh; Piedmont Branch Station, Statesville; and Upper Coastal Plain Branch Station, Rocky Mount).

The object of this work was to carry the farm flock through the winter in the most economical and practical manner in keeping with general farm conditions, utilizing the stalk and stubble field gleanings, cover crops, etc.

An accurate record of the kinds and amounts of feeds eaten and the grazing furnished was kept at the above three farms. The sheep at the Upper Coastal Plain branch station were wintered much cheaper than at the other farms due principally to more cover crops and gleanings being furnished.

5. **Comparison of Temporary Pastures** (Central Station, Raleigh).

The object of this trial was to compare the value of soybeans and Sudan grass as temporary pasture for sheep in Piedmont North Carolina. The work was begun with twenty grade and cross bred lambs which were divided into two equal groups. One group of ten lambs was grazed on soybeans and the other on Sudan grass. The Sudan grass was ready to graze ten days earlier and furnished considerably more grazing than the soybeans (additional sheep having to be turned in to keep the growth down) but the lambs in the soybean lot made noticeably better gains.

SWINE PROJECTS

1. **Mineral Supplements** (College Farm, Raleigh).

It is generally recognized that a mineral mixture, containing calcium and phosphorous, is a beneficial addition to swine rations. In order to study the value of different mineral mixtures when added to a standard fattening ration, sixty pigs were divided into four equal groups and fed for 98 days with the following results.

Group No.	1	2	3	4
Ration	No mineral	Dolomitic Lime	Calcitic Lime	Commercial
Av. In. Wt.	56	56	56	56
Av. Daily Gain	1.06	1.13	1.13	1.09
Feed Consumed per cwt. gain	405	412	423	432
Cost per cwt. gain	$ 9.01	$ 9.08	$ 9.28	$ 9.45

Each group was self-fed free choice, shelled corn and fish meal in addition to the mineral indicated above. The mineral mixture in Groups 2 and 3 was composed of 10 pounds of ground limestone, 10 pounds of superphosphate and 2 pounds of salt.

2. Fish Meal versus Whale Meal (College Farm, Raleigh).

This trial with whale meal as a supplement to corn for fattening pigs corroborates the work reported last year. A chemical analysis of the whale meal showed only 49.94 per cent protein as compared with 55 per cent for the fish meal and would, therefore, be expected to be somewhat less efficient. However, the difference in the protein content of the two feeds is not sufficient to warrant the wide variation in feeding value. The pigs receiving fish meal consumed more feed but made more rapid gains than those receiving whale meal. After being on feed for 56 days those consuming fish meal averaged 117 pounds in weight while those that were fed whale meal averaged only 81 pounds.

3. Cottonseed Meal for Fattening Pigs (Swine Research Farm, Raleigh).

Cottonseed meal, due to its availability and relative low price as compared with other high protein feeds, is popular as a feed for livestock. However, the vegetable proteins, as a class, are not as valuable as those from animal origin but can sometimes be mixed advantageously with animal proteins. In this feeding trial twelve pigs averaging 71 pounds in weight were self-fed free choice, shelled corn, a mixture of fish meal 1 part and cottonseed meal 2 parts, and mineral, while a similar group was fed in the same manner except that they received fish meal alone as the protein supplement.

After a 70 day feeding period it was found that the pigs getting fish meal alone had made an average daily gain of 1.35 pounds, consumed 371 pounds of feed for each 100 pounds gained and made a profit per pig of $3.56, while the pigs that received cottonseed meal made an average daily gain of 1.47 pounds, consumed 380 pounds of feed for each 100 pounds of gain and made a profit per pig of $4.05. The cottonseed meal—fish meal mixture was apparently more palatable than the fish meal since the pigs consumed 750 pounds of the mixture during the period as against 468 pounds of the fish meal when fed alone.

4. Cost of Raising Pigs (All Stations).

The manuscript has been prepared for a Bulletin covering the data collected on this project.

5. A Study of Factors Causing Lameness and Death Among Pigs (Blackland Branch Station, Wenona).

There has been difficulty with the fall farrowed pigs at this Station since 1925. In one to two months after the pigs were put into the fattening pens some of them would get so lame they could not walk and occasionally one would die. The general remedy for this condition has been to turn the pigs out of the pens on to rye pasture for a short while each day, but this year the dry lot rations were supplemented in an effort to alleviate the trouble. Sixty pigs averaging 93 pounds in weight were divided into four equal groups on January 2. They were kept on floored pens from this time until

they were ready for market on March 19 or 76 days, except that they were driven a short distance to the scales each 14 day period throughout the trial.

Each of the four groups were fed shelled corn, fish meal and mineral from self feeders. White corn was fed to Groups 1, 3, and 4 and yellow corn to Group 2, and for each 3 pounds of fish meal fed to Group 3 one part of ground soybean hay was added while 1 pound of alfalfa meal was added to each 3 pounds of fish meal for Group 4.

Eight of the pigs in Group 1 developed some lameness, although none of them died, while none of the pigs in the other three groups were effected. Group 2 receiving yellow corn made more rapid gains, consumed less feed per unit of gain, and was more profitable than any of the other groups.

Pigs from yellow corn group at end of test

6. Value of Permanent Pasture for Fattening Pigs (Swine Research Farm, Raleigh).

Profitable livestock production is dependent on good pastures but it is difficult to measure accurately their exact value for pigs because of the fact that, even with good grazing, the major part of the swine ration must consist of concentrated feeds.

A good orchard grass pasture was selected to study the value of pasture for pigs being finished for market. Sixty spring farrowed pigs averaging 51 pounds in weight were divided into three equal groups and the following results were obtained.

Group No.		1	2	3
Average Daily Gain per Pig		1.42	1.66	1.61
Pounds Feed Consumed Per Cwt. Gain	Corn Meal	304	294	336
	Wheat Shorts	24	22	13
	Fish Meal	31	29	17
	Mineral	7	7	7
	Pasture (acres)	None	.0166	.0165
Cost per Cwt. Gain		$ 10.79	$ 10.66	$ 11.12
Profit per Pig Over Feed Cost		1.67	2.41	1.72

Each group was hand fed twice daily as much of the grain mixture as they would consume and the protein content of the ration was decreased as the pigs increased in weight. Groups 1 and 2 were fed an identical grain ration but Group 2 was allowed one-half acre of orchard grass pasture in addition. Group 3 was confined in a one-half acre lot containing orchard grass and was fed the same kind of concentrates as the other two groups. However, the protein feeds (shorts and fish meal) were limited, to one-half the quantity included in the mixtures for Groups 1 and 2, to see if the protein furnished by the pasture would replace a part of that fed in the grain ration.

Pigs in Group 2 with Orchard Grass in foreground

Representative areas were fenced, in each of the pastures, and at the beginning, at the close, and at 28 day intervals during the trial these areas were clipped and weighed together with a similar area that had been grazed.

7. A Study of the Utilization of Crops (Upper Coastal Plain Station, Rocky Mount).

A three year rotation with corn, cotton, and soybeans is included in this experiment to study the effect on the yield of cotton when the other two crops, together with cover crops, are utilized by pigs. Since the three one acre plats, set aside for this work, were planted to cotton during the past year pigs were used only to graze the rye that was seeded in the fall as a cover crop. Two acres of this rye furnished grazing for 92 days for sixteen 69 pound pigs and in addition to the pasture they consumed 9,931 pounds of grain and 157 pounds of mineral.

8. Soft Pork (Swine Research Farm, Raleigh).
(In Coöperation with Dr. J. O. Halverson)

The work this year was planned so as to study the effects of feeding cottonseed meal in the hardening ration. Peanuts were again used as the principal constituent of the softening ration and was fed prior to the hardening ration.

The pigs used were divided into two groups according to their initial weights, one group being started at an individual weight of 35 to 40 pounds while in the other group the different individual pigs weighed approximately 65 pounds when they were started on the peanut or softening ration. A slaughtering weight of 225 pounds was anticipated for all pigs but in order to reduce the number of shipments to Beltsville some deviation from this optimum weight was necessary. The pigs in the lighter group were changed from softening to hardening feed when they had attained an average weight of about 80 pounds while those in the heavier group were carried to a weight of approximately 100 pounds before being changed to the hardening ration. Each pig, therefore, made a gain of 40 to 50 pounds and 35 to 40 pounds respectively in the two groups while on softening feed.

Three pigs from each weight class were fed individually throughout both the softening and hardening periods while the remaining pigs in the different groups were fed collectively, making a total of 24 pigs fed after this plan.

This year's results are in accord with the two previous years work with corn and cottonseed meal 6:1 as a hardening ration. The two groups having average initial weights of 35 pounds and 65 pounds both furnished satisfactory carcasses at good marketable weights, in the different trials covering three years experiments, with one exception. This year Pig No. 4, was graded medium soft when according to his initial, change and final weights and when his rate of gain is considered, there seems to be no reason why he should not have graded as firm as No. 3 and No. 5 which were fed individually in the same series, or as firm as Pigs No. 15 to 21 inclusive which were group fed at approximately the same weights as Pigs Nos. 3, 4, and 5.

It is interesting to note the satisfactory gains made by the different pigs during the hardening period on a ration containing slightly more than 13 per cent cottonseed meal. In fact, Pigs Nos. 15 to 21 inclusive consumed on the average one pound daily of cottonseed meal for 68 days, and made an average daily gain ranging from 1.76 to 2.10 pounds.

This work is being continued as a part of the coöperative project on Soft Pork in which this Station is coöperating with a number of the other State Experiment Stations and the U. S. Department of Agriculture, Bureau of Animal Industry, in studying this problem.

DAIRY INVESTIGATIONS

C. D. GRINNELLS, in Charge

Dairy Research is carried on at the following Stations: Central Experiment Station Dairy, Raleigh, Wake County; Coastal Plains Branch Experiment Station, Willard, Pender Co.; Mountain Branch Experiment Station, Swannanoa, Buncombe Co.

The study of methods of control and eradication of Bangs Disease or Bovine Infectious Abortion is also in progress. This study is carried on with twenty-five representative dairy herds in different sections of the State. It is a coöperative project with the Veterinary Division of the North Carolina Department of Agriculture.

DAIRY CATTLE PASTURE MANAGEMENT STUDIES I

This is a study of the effect of medium and heavy early grazing on the life of pastures. Two plats, each containing three acres, comparable in topography, character of soil and character of plant cover are being used.

Plat I. This plat is being grazed by four cows. (Normal or medium grazing.)

Plat II. This plat is being grazed by five cows. (Heavy grazing.)

The condition of the plats at the end of the second grazing season is as follows:

Plat I. This plat has a good turf with an even distribution of grasses and clover. There is sufficient growth to protect the grass roots during the winter. With the exception of a few small areas which need to be reseeded this plat appears to be in excellent condition.

Plat II. This plat has a fair distribution of the different grasses but the stand is not near as good as on plat I. There is less white clover than on Plat I. There is not enough growth left to protect the roots or to prevent erosion in places.

This is a coöperative project with P. H. Kime of the Agronomy Division.

DAIRY CATTLE PASTURE MANAGEMENT STUDIES II

This is a study of the Intensive System of Grassland Management originated in Germany in 1917 and there known as the Hohenheim System. This system is based on the following principles:

1. Division of pasture area into plots.
2. Fertilization with concentrated fertilizers.
3. Division of cattle into groups.
4. Rotation of groups of cattle.

Eight plots each containing two and one-half acres are being used. Six of these plots are fertilized and two are being used as checks.

Approximately eighty per cent of the area is of the Cecil Clay Loam Series. The remainder is of the Cecil Sandy Clay Loam and Worsham

Sandy Loam. The land making up the plots is very irregular in contour. Five plots have a very marked slope to the north of approximately 20 to 25 inches to 100 feet. The three plots facing south have an equal slope. All plots are cut by terraces. The irregularity in contour is marked in all plots and while the slope is not in the same direction the plots average uniform. The area used is typical of waste land in this state which should be converted into pasture.

The carrying capacity of the twenty acres included in the project was increased considerably. The time of application and the quantity of fertilizer used varied with the different plots. One plot received a basal application only while some plots received as high as five applications.

The fertilizer was broadcast and at first it could be noted that the distribution was not very even. This was corrected and during the remainder of the season distribution was fairly uniform.

The first season was an unusual one in that the rainfall was heavier than during the average year. Following is a record of the weekly precipitation taken at Raleigh Station No. 2, which is just a short distance from the pasture.

A Record of the Weekly Precipitation							Precipitation for same month during Preceding five years.				
1929	1st wk.	2nd wk.	3rd wk.	4th wk.	5th wk.	Total	1928	1927	1926	1925	1924
March	2.63	1.65	1.18	0.38	0.00	5.84	3.46	3.41	4.29	2.50	2.72
April	0.00	0.00	2.01	0.19	0.41	2.83	5.93	2.77	2.45	2.44	4.44
May	0.47	1.41	0.14	1.48	1.12	4.62	4.76	2.50	1.67	2.80	5.27
June	0.46	1.91	0.40	2.93	0.00	5.70	5.49	4.93	3.89	3.91	5.31
July	1.54	2.05	0.68	1.19	0.00	5.46	4.87	5.40	5.46	3.00	6.42
August	1.40	0.86	0.02	0.53	0.47	2.28	8.39	5.57	4.34	2.75	3.97
September	0.44	0.58	0.06	0.84	1.68	3.60	11.18	1.98	1.69	2.03	10.66
October	6.82			1.36	0.23	7.33	2.55	3.96	1.84	3.50	1.11

This is a coöperative project with P. H. Kime of the Agronomy Division.

DAIRYING AS A SUPPLEMENTARY ENTERPRISE

This is a study of dairy cattle as a supplementary enterprise to cotton farming in North Carolina. It is an attempt to secure more definite information on a farm enterprise which may be used to supplement cotton in the utilization of land and labor, and as a source of farm income.

The project is divided into three parts, as follows:

1. Cotton grown in a three year rotation with feed crops for dairy animals, manure being returned to the soil.

2. Continuous cotton.

3. Cotton grown in a three year rotation without dairy cattle utilization or the addition of manure.

The first seasons crop has been harvested and eight head of cattle were placed on the project on November 1. The chart shows the plan of rotation and the layout of the fields.

FIELD M—CENTRAL STATION
Cropping Plan
Coöperative Dairy Utilization Project

1929 Layout

765	4	3	2	1
	Cotton (continuously)	Cotton (followed by rye and Vetch as a cover crop)*	Soybean Hay	Corn and Soybeans (followed by barley and vetch for hay)
1a1a1a	5a	8a	8a	8a

*No manure to be applied.

ROTATION FOR FIELDS 1, 2 AND 3

Year	Field Number		
	1	2	3
1929	Corn	Hay	Cotton
1930	Hay	Cotton	Corn
1931	Cotton	Corn	Hay
1932	Corn	Hay	Cotton
1933	Hay	Cotton	Corn
1934	Cotton	Corn	Hay
1935	Corn	Hay	Cotton
1936	Hay	Cotton	Corn
1937	Cotton	Corn	Hay
1938	Corn	Hay	Cotton

This is a coöperative project with the Agronomy and Farm Management Departments.

BOVINE INFECTIOUS ABORTION

This is a study of the segregation plan in controlling and eradicating Bovine Infectious Abortion.

There are twenty-five herds included in this project and the herd management varies from complete segregation of reactors, segregation with modifications, down to one herd practicing excellent sanitation and segregating all cows only at calving time.

The results of this study for the past year indicate:

1. That the average dairyman expects one hundred per cent results even though his segregation is only partial.

2. That the product from the reactor herd must be cared for in such a way that it will not carry infection back to the negative herd.

3. That partial segregation or separation of negative and positive animals in the same barn when accompanied by good sanitation will give results.

In coöperation with Dr. William Moore and Dr. L. J. Faulhaber, Veterinary Division of the North Carolina Department of Agriculture.

CORN SILAGE VERSUS SORGHUM SILAGE

FEED CONSUMED PER UNIT OF PRODUCTION

Unit of Product	Hay Lbs.	Silage Lbs.	Grain Lbs.
Per 100 Pounds of Milk			
Corn Silage Ration	54.	135.	18.1
Sorghum Silage Ration	60.	150.	20.0
Per Pound of Butterfat			
Corn Silage Ration	20.54	51.3	7.24
Sorghum Silage ration	21.7	54.31	7.24

This feeding trial covered a period of 120 days. The feeding periods were arranged according to the double reversal method which allows for a comparison of the first and third periods within the same group.

The following basal ration was fed to both groups:

Alfalfa Hay
Grain Mixture

Corn Meal	400
Cottonseed Meal	300
Wheat Bran	200
Ground Oats	100

Corn or sorghum silage was added to this ration, depending upon the experimental period the lot was in.

MOUNTAIN BRANCH STATION

DAIRY HERD DEVELOPMENT

This project is a study of the possibilities of herd development when young sires whose pedigrees indicate high production are used. The proven sire is not usually priced within reach of the average dairyman. This class of producers is forced to depend on young sires with an inheritance indicating high production. These data should indicate the possibilities and limitations of a progressive improvement over a long period when this system of selection is consistently used.

This Station has also aided in developing the dairy industry in Western North Carolina in that during the past year seven purebred females and six purebred bulls have been sold for breeding purposes. Over six hundred visitors, not including those entertained during picnics or other special days, have shown an active interest in the dairy. Over two hundred letters

were written answering questions concerning breeding, feeding and management of dairy cattle.

This herd is made up largely of heifers sired by Sybil's Gamboge of Swannanoa 254225.

DAIRY CATTLE PASTURE MANAGEMENT STUDIES III

This is a study of intensive grassland management under Western North Carolina conditions. The pasture is covered with an excellent sod and it is being divided into five three-acre plots. The plots are all similar in soil type and topography.

Four plots will receive varied fertilizer treatments the application of which will be started on March 1, 1930.

The herd will be divided into groups:

Group I—High producers.
Group II—Low producers.
Group III—Dry cows and heifers.

Each plot will be grazed by Group I until the choice vegetation is removed. Then Group II follows and grazes each plot until Group I is removed from the next plot. Group II is then followed by Group III which continues until the next cycle or trip around.

BLACKLAND BRANCH STATION

COMMUNITY BREEDING STUDY

This Station maintains a purebred Guernsey bull, Wenona Chief of Bachelor's Retreat No. 126468 for the use of the community. A small service fee is charged to pay part of the cost of maintenance. In a period of two years seventy-two cows have been bred. With a county cow population of 604 this indicates that the cow owners appreciate a good purebred sire and will use him if within a reasonable distance. With one exception the cows bred were family cows. Reports indicate that this young sire has already greatly influenced the uniformity of the young stock in this section.

OXFORD BRANCH STATION

COMMUNITY BREEDING STUDY

This Station maintains a purebred Jersey bull, Oxford's Jubilant Fern No. 315098. A service fee is charged to defray part of the cost of maintenance. During a period of twenty-one months ninety-one cows have been bred. The use of this sire indicates an increased interest in dairying in this section.

COASTAL PLAINS BRANCH STATION

DAIRY HERD DEVELOPMENT

This study is to determine the possibilities of continuous herd improvement without the use of proven sires. Sires with pedigrees indicating the ability to transmit high production are used.

During the past year a number of new herd records have been added to the data. A number of daughters of The Distinguished Eminent are now on

official test. Eminent's Gay Lucile, the first daughter of this sire to finish a record, is credited with the following by The American Jersey Cattle Club:

Milk	*Fat*	*Age*
9,864	547.8	2-3

This Station has made an able contribution to other herds in the way of breeding stock. Twenty-two purebred females and eight purebred males have been sold during the past year. This Station has also contributed much in the way of information on breeding, feeding and management. The milk house and equipment have been closely studied by a number of dairymen installing similar equipment.

SHOCKED SORGHUM VERSUS CORN SILAGE

This is a study of shock sorghum as a substitute for corn silage. The herds in Eastern North Carolina are in most cases considered too small to justify silos. This Station is working with crops which will furnish a succulent feed which can be cheaply stored.

This feeding trial was started in January or in about the middle of the winter feeding period in this section.

Feeds consumed per pound of butterfat:

	Grain	*Hay*	*Shocked Sorghum*	*Corn Silage*
Shocked Sorghum	10.2	6.4	32	....
Corn Silage	9.1	8.0	....	26

The shocked sorghum did not compare as favorably with corn silage as the data would indicate. It was not palatable and a large amount of it was refused.

FARM DAIRY REFRIGERATION

This is a collection of data on an electric cooler at the Coastal Plains Station. The average monthly current consumption was 222 Kilowatt hours. Figured at the commercial rate of 4 cents per KWH this amounted to an average monthly cost of $8.88 for dairy refrigeration.

Detailed records are kept as to temperatures and costs per unit of product for refrigeration. These data are being summarized for a progress report.

This project is conducted in coöperation with W. L. Clevenger, of the Dairy Manufacturing section.

ANIMAL NUTRITION INVESTIGATIONS

J. O. Halverson, in Charge

The work in this division has been concerned with two major problems, Soft Pork due to peanut-fed hogs, and the effect of feeding cottonseed meal and hulls to cattle in large amounts. These problems have been under way for some time. Data and results have now been obtained on both these difficult problems which makes it desirable to publish. The manuscript containing the material of the latter problem is nearing completion for publication. The former problem has yielded results by the use of cottonseed meal with the corn ration.

Both of these problems and their results will be discussed at some length.

SOFT PORK

(In Coöperation with Earl H. Hostetler)

The past year we have studied the use of cottonseed meal with corn on peanut-fed pigs in its effect upon the hardness of both external (back) and internal (kidney) fat by means of the chemical analysis of these fats for the fat constants of melting point, iodine absorption number and refractive index by passing a beam of light through the melted fat and measuring the amount it is bent out of a straight line.

The fats as they were rendered from the adhering tissue, began to harden as soon as they filtered off. This was readily noticeable to any one entering the room while this process was in operation. The bottled fats, both back and kidney, when allowed to stand in the hot laboratory over night, solidified and became quite hard in contrast to the usual samples obtained from peanut-fed pigs hardened with corn alone. These preliminary observations gave an approximate indication of the condition of the fats and of the effect of the ration on the pigs themselves as to whether they would grade hard, medium hard or medium soft. A chemical analysis of these fats confirmed the preliminary observations made as to hardness.

These results confirm the carcass grading for hardness. They also confirm the hardening effect of the two preceding years of cottonseed meal in the corn ration over that produced by corn alone. The degree of hardness obtained this past year did not differ materially from that of the previous two year's results.

Below are given, for the past three years, the results by averages of the fat constants (back fat) for both 35 and 60 pound pigs fed peanuts followed by the usual corn ration alone with 12.4 per cent cottonseed meal supplied.

Number of Pigs			Hardening Ration	Melting Point	Iodine Absorption No.	Refractive Index
35 lb.	60 lb.	Total				
9	9	18	Corn	37.6° C.	65.7	1.4601
31	32	63	Corn with C. S. Meal	44.2	61.6	1.4596
			Difference	6.6 deg.	4.1 units	5 points

From the above table it will be noted that the fats obtained from the cottonseed meal-fed pigs had an average melting point of 6.6 degrees higher and an iodine absorption number of 4.1 units lower and also a refractive index of 5 points lower than the fats from the corn hardened pigs.

It is thus seen that the melting point is most markedly affected (17.6 per cent), the iodine numbered lowered 6.24 per cent showing less unsaturated (soft) fat present. The refractive index was lowered 5 points, 0.8 per

cent, confirming the other constants. The results of the internal or kidney fat are of a similar order.

PROGRESS OF PREPARATION FOR PUBLICATION OF MATERIAL AND DATA OF PREVIOUS WORK IN FEEDING OF COTTONSEED MEAL TO CATTLE

(In Coöperation with Mr. R. S. Curtis and Dr. C. D. Grinnells)

During the past year considerable effort and time have been given in the preparation of this material for publication. Tables, graphs and the voluminous data of 69 head, fed individually from 1920 to March 1, 1928 together with the results of the work with small animals, has been analyzed and written up. Included are also the results of unpublished work previous to 1920.

The data of this work is extensive, including a study of the effect of cottonseed meal with hulls alone: the effect of a ration consisting of corn, corn silage and corn stover; and a ration of cottonseed meal with corn silage alone. A ration of cottonseed meal and white corn with corn silage, corn stover and hulls is included.

The later work of 1925-1928 is more concerned with a study of the effect of various kinds of combinations of roughage with cottonseed meal alone or with corn. Thus, we have studies of both the concentrate with hulls and with other roughages in their bearing on the problem of properly supplementing a ration of cottonseed meal with or without corn.

Preparation of this material for publication is nearing completion.

THE STUDY OF VITAMIN A IN RELATION TO LARGE AMOUNTS OF COTTONSEED MEAL AND HULLS FED TO CATTLE

(In Coöperation with Mr. Earl H. Hostetler)

This project is a continuation of the effort to specifically determine and prove the exact relation of Vitamin A to the need of cattle when a ration consisting chiefly of cottonseed meal and hulls with minerals is fed. It has been shown that cattle require this substance and that it must be supplied by the ration. Previously two head had been thus tested for the ability to supply this substance when cottonseed meal, hulls and beet pulp with minerals formed the only feed which they received. Cod liver oil and some yeast had also been fed. The results secured by examination for storage of Vitamin A in the livers did not show the presence of any. It might be said that these two head received enough Vitamin A but that there was no excess and consequently no storage in the liver.

In an effort to prove that there was not only no storage but actually a deficiency, 2 steers to date have been allowed to die on the insufficient ration of cottonseed meal, hulls and beet pulp fed them as given in the report of Mr. Hostetler on this project. One representative head was killed before these animals were placed on this ration. Its liver was tested for the presence of Vitamin A. The same was done with the livers of the two head which died after 183 days on the ration.

Incomplete results to date appear to substantiate the belief that these steers suffered from a deficiency of Vitamin A.

The definite proof when completed is important in establishing one fact, that the so-called cottonseed meal poisoning may be due to the absence of necessary constituents in the ration; in this instance Vitamin A. Especially is this important as long as large amounts of cottonseed meal and hulls are fed when pasturage and roughage are scarce, and in view of the fact that meal and hulls are always readily available.

Other methods of attack on this problem are being pursued with small animals and with the remaining steers. This work has not progressed far enough to date to report on.

VITAMIN B CONTENT OF RAW PEANUTS AND PEANUT MEAL

(In Coöperation with Mr. F. W. Sherwood)

The peanut and peanut meal has been previously studied for the distribution of Vitamin B Content. It seemed desirable to ascertain further the amount of the constituents of Vitamin B complex, i.e. the anti-neuritic and the anti-pellagra components in as much as peanuts have been recommended as a source of the anti-neuritic fraction for the East Indian troops in the field and it is desirable to have this information also before our study is published.

This also necessitates testing materials and methods in order to estimate the components of Vitamin B complex. The whole raw peanut is used and several samples of commercial peanut meal of high grade.

This work is now under way.

STUDY OF THE EFFECT OF THE RATION ON HEALTH, REPRODUCTION AND ABILITY TO REAR THE YOUNG

(In Coöperation with Mr. F. W. Sherwood)

In using the albino rat for experimental purposes it is necessary to have an animal of a standard type. For that purpose we raise our own rats upon

TABLE NO. 1

PARTIAL PEANUT RATION WITHOUT WHOLE MILK AND GREEN FEED (CABBAGE) SHOWING MODIFICATIONS USED IN THE STUDY OF REPRODUCTION

Ration	No. 192	Modifications				
		B	C	D	E	F
Peanuts (18% protein)		Constant for all modifications				
Wheat Embryo Middlings	16	16	16	0	16[2]	16[2]
Val. Meat Residue	7½	0	7½	7½	0	0
Dried Liver	0	0	0	0	0	7½
Meat Scrap[1]	0	7½	0	0	7½	0

[1]Commercial; fed cod liver oil 0.5 cc and dried brewer's yeast .45 gm. per rat per day separately in the modifications.

[2]Ether Extracted.

known, carefully prepared rations or diets. Thus, it has always been found necessary to feed whole milk daily and green feed on alternate days. For experimental purposes, it would be desirable to have a complete dry diet, thus making it unnecessary to feed liquid whole milk and the raw green feed (cabbage) separately.

In an effort to compound two rations fulfilling these requirements, this work has been continued. The effect of the rations are judged by the vigor, physical condition, and health of the adults and upon their ability to reproduce and rear their young through successive generations with undiminished vitality.

TABLE NO. 2

SHOWING THE

PARTIAL CEREAL RATION WITHOUT WHOLE MILK AND GREEN FEED (CABBAGE) WITH MODIFICATIONS

Ration—Cereals	No. 193[1]	Modifications		
		B	C	D
Skim Milk Powder	10	10	0	10
Wheat Embryo Middlings	14	4	14	4
Val. Meat Residue	0	10	0	0
Dired Liver	0	0	10	10

[1]Wheat, corn, rolled oats, 20% each, linseed meal 10, alfalfa flour 5; NaCl and CaCO, 0.5% each; K I .0001%. Fed separately, daily, per rat 6 drops wheat embryo oil and ¼ cc. cod liver oil.

Two rations have been used, one whose protein is furnished by raw peanuts and another, a cereal stock ration used for our colony. In Tables 1 and 2 are shown the modifications made in these two rations. Tables 3 and 4 give summaries of results on reproduction and the ability to rear the young, upon the modification of these rations.

Upon the peanut ration containing 7½ per cent Valentine's Meat residue with or without 16 per cent wheat germ middlings (Rations 192 C and D respectively—Table No. 1), the rats do not appear able to rear their young. The F_4 generation has been obtained upon each diet. An inspection of the summary in Table 3 shows that upon Ration 192 C (containing meat residue and wheat germ) there are now living only one male and female of the fourth generation that of 10 litters produced, only 6 have been seen or found and of these no young have been raised after 8½ months. Likewise on Ration 192 D containing the meat residue alone, the F_4 generation of 4 rats at four and a half months have produced only one litter not seen. This generation is behaving as the preceding F_3 generation which produced a total of 11 litters in which 4 were seen and 1 litter of 4 young raised consisting of F_4 generation.

TABLE NO. 3

GIVING A SUMMARY OF RESULTS OF REPRODUCTION AND ABILITY TO REAR YOUNG ON THE PEANUT RATION WITHOUT WHOLE MILK AND RAW CABBAGE

Lot	Ration	Generation	Date Began	No. and Sex in Lot	Results
462	192 D	F3	2- 5-29	2 M & 3 F	Now 2 males and 2 females
	Total 7 litters not seen, 4 litters seen, 1 raised, 4 y-F4 L. 500				
500	192 D	F4	Total 1 litter not seen, 0 litters seen, 0 raised at 4½ months.		
463	192 C	F4	4- 5-29	1 M & 2 F.	Now 1 male and 1 female.
	Total 4 litters not seen, 6 litters seen, 0 young raised at 8½ months				
489	192F	F4	4-18-29	2 M & 3 F.	All living
	Total 3 litters not seen, 7 litters seen, 5 litters raised of 33 y.				
501	192F	F5	7- 9-29	2 M & 2 F.	----------
	Total 0 litters not seen, 3 litters seen, 2 litters raised of 6 y.				
526	192 F	F6	10- 7-29	2 M & 3 F.	Too young to breed

TABLE NO. 4

GIVING RESULTS ON REPRODUCTION AND ABILITY TO REAR THE YOUNG UPON A CEREAL RATION MODIFIED WITHOUT WHOLE MILK AND RAW CABBAGE

Lot	Ration	Generation	Date Began	No. and Sex in Lot	Results
477	193 C	F5	2-17-29	2 M & 3 F.	----------
	Total 1 litter not seen, 4 litters seen, 3y. raised				
514	193 C	F6	9-16-29	2 M & 1 F.	Too young to breed
499	193 D	F0 (Stock Rat)	7- 9-29	2 M & 4 F.	----------
	Total 0 litters not seen, 4 litters seen, 3 litters died, and 1 litter of 4 nursing young at 3½ months.				

The results with another modification, 192 F, of 16 per cent ether extracted wheat germ middlings and 7½% dried liver gave more favorable results to date.

The F_4 generation has produced a total of 10 litters of which 7 were seen. Five of these litters raised 33 young. The original F_4 lot of 2 males and 3 females are still living. The F_5 generation produced 3 seen litters, 2 of which raised 6 young which constitute the F_6 generation.

It has not yet been determined whether this result can be obtained without the use of ether extracted wheat germ or whether it is due to the dried liver alone or to both substances.

With minerals and all known deficiencies supplied in the ration the results to date indicate that the quality of protein alone (meat residue) is not sufficient to enable the rats to rear their young.

The results with the cereal Ration No. 192 C and D are similar to the above. The lot of rats on Ration 192 B did not rear any young and was discontinued. On Ration 192 C, 3 young, F_5 generation, were raised out of 5 litters. It was necessary to take a lot of stock rats (Fo) in order to use Ration 192 D with 10 per cent dried liver, skim milk powder and wheat germ.

To date our results of a cereal ration without whole milk and green cabbage have not been promising when using combinations of skim milk powder, wheat germ, and Valentine's meat residue.

R. H. RUFFNER,
Head, Animal Husbandry Department.

RESEARCH IN BOTANY

DIVISION OF PLANT PATHOLOGY

S. G. Lehman, in Charge

TOBACCO MOSAIC

This disease is wide spread and causes large losses in the state. The question of survival of the causal agent in the soil of tobacco fields is an important one. Three tests conducted in fields which had a high percentage of mosiac in the previous summer gave conflicting results in regard to the relation of the disposal of the old stalks and roots to overwintering of the mosaic virus. However, the results of all three tests are interpreted to indicate that the common tobacco mosaic virus does persist in soil from one growing season to another and enters growing plants through their roots.

TABLE I

Percentage of Tobacco Mosaic in Topped and Untopped Plants Growing in the Same Fields

Field No.	Percentage of Mosaic in	
	Untopped Plants	Topped Plants
A	2.3	8.7
B	11.0	35.9
C	5.0	38.7
D	9.2	57.8
E	13.3	73.1

A number of infested fields were found in which a considerable proportion of the plants made a slow start in the spring and remained untopped up to the end of the harvest season. These untopped plants were scattered among other plants which had been topped at the usual time. With the one exception noted below, the topping had been done without any precaution to avoid spread of mosaic by indiscriminate handling of diseased and healthy plants. Counts were made to determine the percentage of mosaic in the topped and untopped plants. The results are shown in Table I.

Much more mosaic was found in the topped than in the untopped plants. In field A some care had been used to avoid handling diseased plants while topping healthy ones. In this field mosaic developed in only 8.7 per cent of

the topped plants, while in the other fields, in which mosaiced and healthy plants were topped without any attempt to avoid contamination of the workers' hands, 35.9 to 73.1 per cent of the topped plants became diseased. No suckering had been done in fields B, C, D and E and no priming had been done in fields C and E when the counts were made. The counts indicate that the percentage of mosaic plants is greatly increased by indiscriminate handling of diseased and healthy plants in the topping operation.

COTTON SEED TREATMENTS

The treatment of cotton seed with certain chemical dusts as a means of obtaining better stands has given encouraging results again this year. Tests were placed on a number of farms. On 18 of these farms counts were made to determine if the dusts gave sufficient protection to the seed to appreciably increase the number of seedling plants. On 11 of the 18 farms definite increases in number of seedling plants ranging from 25 to 100 per cent or more were obtained on the treated rows. On five farms neither consistent increases nor decreases in stand resulted from the treatments. On the remaining 2 of the 18 farms the treatments apparently reduced the number of seedlings. In these 2 tests fewer plants grew on the treated than on the untreated rows. However, there is some doubt as to whether this decreased stand resulted from seedling injury caused by the treatment or came about from some other cause.

Fig. 1. Cotton seed treatment test on Upper Coastal Plain Test Farm, Edgecombe County. The middle row and the third row on each side of the middle row are untreated check rows. The seel planted in the two rows on the right and in the two on the left of the middle row was dusted with a mercury compound before planting. Note the better stand in the treated rows.

On several of the 18 farms, treated and untreated seed were planted on three different seeding dates; namely, early, medium early, and the normal or

usual safe planting date. In the early planting (made about 4 weeks before the safe planting date) better germination was always obtained on the treated rows, but the prolonged periods of unfavorable weather to which these seedlings were subjected often resulted in the death of many of them and caused poor stands even on the treated rows. The greatest permanent benefit in improvement of stand from the treatment was observed on cotton, planted medium early, that is, one to two weeks earlier than the time which is usually regarded as the safe planting date for the community in which the test was made. In the cotton planted at the normal or usual safe planting date, better stands were usually but not invariably obtained on the treated rows, but in these cases the increases directly attributable to the treatments were usually not so great as with earlier planted cotton. Table II shows the results obtained in a test run on the farm of Mr. J. V. Harrington, Sanford, N. C.

TABLE II

AVERAGE NUMBER OF COTTON PLANTS IN 100 ft. OF ROW ON PLATS PLANTED TO TREATED AND UNTREATED SEED ON THE FARM OF MR. J. V. HARRINGTON, SANFORD, N. C.

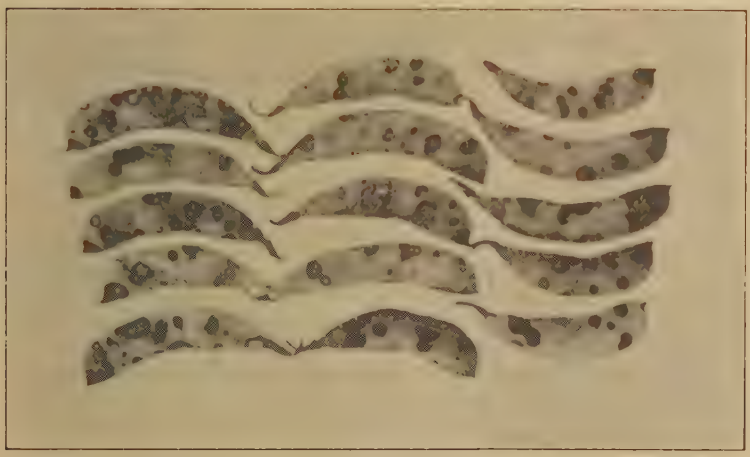
Date of Planting	Average number of seedlings in 100 ft. of row on dates given						Percentage of complete stand of chopped cotton on[4]	
	May 13		June 5		June 31			
	Untreated rows	Treated[1] rows	Untreated rows	Treated[1] rows	Untreated rows	Treated[1] rows	Untreated rows	Treated rows
April 10	96[2]	230	40[3]	107[3]	----------	----------	26.6	71.3
April 23	184	390	80[3]	154[3]	----------	----------	53.2	102.6
May 14	----------	----------	186	597	92[3]	152[3]	61.3	101.3

[1]Seed dusted with ethyl mercury chloride, 3 oz. per bushel.
[2]Each number is the average of seedlings counts on 3 rows.
[3]Counts made after cotton had been "chopped" or thinned to a stand.
[4]150 plants per 100 ft. of row is assumed to represent a complete stand.

SOYBEAN DISEASES

The work on this project has consisted chiefly of attempts to control frogeye (*Cercospora diazu*) by seed treatment. The frogeye fungus not only attacks leaves and stems but it grows through the pod wall and enters the coat of the seeds. The materials used for treating the seed were 70 per cent ethyl alcohol, Semesan solution, Formaldehyde solution, mercuric chloride solution, Improved Semesan Jr. dust, Smuttox dust, ethyl mercury chloride dust, organic mercury acetate dust, and mercury furfuramide dust. None of these materials gave satisfactory control of frogeye. Soaking the seeds in water at 112° F. for periods of 15, 20, and 25 minutes failed to free

Fig. 3. Showing injury to Soybean leaves caused by frogeye disease



d Fig. 4. The frogeye disease on soybean pods. Most of the seeds in such pods are infected and, if planted, will produce a diseased crop.

them of disease. Temperatures higher than 112° or longer periods of soaking at 112° greatly reduced germination of the variety tested (Otootan).

The fungus which causes frogeye readily overwinters on diseased stems, leaves and pods left in the field after harvest. The disease was found on volunteer Otootan and Laredo plants in a number of fields visited during the first week of April. At this time spores of the frogeye fungus were being produced abundantly on the old stems and leaves of the 1928 crop

and spore bearing lesions were numerous on the green leaves of the volunteer plants. All of these fields had been plowed in the fall after the bean seed from the diseased plants had been harvested and the stems had been returned to the land. One of the fields was plowed again in the following May and reseeded to soybeans harvested from a field free of frogeye. By the time the plants from these seed were 6 to 8 inches tall, frogeye appeared on them and the disease became abundant by the middle of the growing season. It is doubtful if diseased stem, pod and leaf material can be turned under sufficiently well by plowing to prevent a recurrence of frogeye if susceptible soybean varieties are returned to the land in the season following the diseased crop.

The frogeye fungus was found to be alive in 3 year old seeds (Laredo beans grown 1926, planted 1929).

OAT SMUT CONTROL

In connection with our studies on seed borne diseases, tests have been made of a number of materials for control of loose smut of oats. The methods heretofore recommended for control of this disease have required wetting of the seed oats with solutions of formaldehyde. Tests made in the past year show that this disease can be controlled by the use of a number of chemicals applied as dusts. Ceresan, the trade name of a dust now being widely advertised for oat smut, gave good control. Smuttox, a dust containing formaldehyde gas, gave perfect control of loose smut but this material is not at present available in commercial quantities. Formaldehyde applied as a spray and mercuric chloride used as a dust almost completely prevented smut, but caused considerable seed injury.

Dusting is recommended in preference to the liquid formaldehyde treatments formerly used for oat smut control. Dust treatments are made more easily and more quickly than liquid treatments and there is less danger of seed injury.

WHEAT RUST

The work of this project was continued under the same coöperative arrangement as in previous years. A large number of varieties and selections were grown and most of them showed a high percentage of rust at harvest time. Yields were taken on each variety and some of the selections are very promising in this respect. The rust came rather late and did not seem to influence yields to any great extent.

Covered smut of wheat is being studied coöperatively with the Office of Cereal Crops and Diseases of the United States Department of Agriculture. A considerable number of wheat varieties are being tested for resistance to covered smut collected in different localities. The results obtained thus far indicate that smut collections from certain sources are markedly more virulent toward the varieties of wheat tested than are collections from other sources. Likewise certain varieties of wheat are more resistant than others to all the collections of smut used in the test.

SWEET POTATO AND DEWBERRY DISEASE INVESTIGATIONS

R. F. POOLE, in Charge

In Storage and Transit with Reference to their Control with Chemical Treatment. In these investigations it was found that black rot caused by *Ceratostomella fimbriatum* is by far the most important disease of sweet potatoes in storage banks. Studies on the life history of this fungus indicate that the soil is a source of infection, but that the potato seed and plant are the greatest source. The fungus was found to live during the growing season on the stem and to fruit abundantly by harvest. The spores are readily disseminated in the handling of the crop during harvest. Sometimes infection takes place before but more often during harvest, with the result that many badly infected potatoes are stored in an apparently healthy condition. A brown rot caused by *Sclerotinia sp* and developing late in the storage season was found to cause heavy loss in both bank and house throughout the state. Sweet potatoes infected with *Schizophyllum commune* were found in Currituck County. The fungus was readily isolated, and with the pure culture inoculation a definite dry rot was produced on the Yellow Jersey potato in laboratory tests. The fungus was shown to be the same species that attacks pine, cherry, apple, peach, and plum. This rot is of no economic importance at this time.

Chemical treatments for the control of diseases in storage were continued. Healthy potatoes inoculated with spores of *Ceratostomella fimbriatum*, treated with Bordeaux mixture 10-10-50 and dusted with hydrated lime, and 25 per cent monohydrated copper sulfate and lime dust greatly reduced infection of potatoes stored in banks. The chemicals were less efficient in the control of black rot and poor results were obtained when diseased potatoes were treated just before banking. Potatoes inoculated with spores of *Rhizopus nigricans* immediately after harvest and treated with hydrated lime and Bordeaux mixture in dust and liquid forms showed much less infection than did inoculated and uninoculated potatoes kept for control checks. Potatoes treated immediately after harvest and before storage showed less decay from *Rhizopus nigricans* than potatoes treated after the storage period. In these studies Bordeaux mixture and lime in both dry and liquid treatments did not injure the potatoes. In one test potatoes were badly injured when treated with a paste of finishing lime.

CAUSAL ORGANISMS

Further results obtained in studying susceptible and resistant varieties of sweet potatoes to *Fusarium batatatis* show that resistance is directly related to vigor. Varieties first to sprout and those most resistant to drought were also most resistant to wilt.

All varieties of sweet potatoes are susceptible to scurf caused by *Monilochaetes infuscans*. However, the potatoes on different varieties at harvest frequently show a wide variation in the amount of infection even though the plants are inoculated and transplanted uniformly. In recent studies it was found that this form of resistance is a result of the arrangement of potatoes on the stem. Varieties such as Nancy Hall, Red, Vineless

and Yellow Jersey, and Yellow Yam, which set potatoes close to the stem are frequently blackened by the scurf, in comparison to slight or no infection of varieties such as the Porto Rico, which sets the potatoes further away from the hill. This difference in infection was later found to be regulated by the spreading of the fungus, especially on lateral potato stems. When growing slowly the fungus may not reach the potato by harvest. However, on varieties that set potatoes near the stem heavy infection takes place from spores being washed downward from the stem. This method of infection was also found to account for greater infection of potatoes developed just beneath the stem than on those set laterally.

In studying the relation of sweet potato varieties to the nematode disease it was shown that the Jersey and Porto Rico varieties and strains continued to be resistant after growing for three consecutive years on the same infected soils. On the other hand Nancy Hall, Red Brazil and related varieties were severely attacked. In this study the physical characters of the varieties, such as color, vigor, texture, and position of potatoes on the stem seemed to have no relation to the control of resistance. The Red Jersey variety being resistant and the Red Brazil very susceptible. The varieties with yellow and lighter colored pigments reacted in a similar manner to these red pigment varieties because some were resistant and others very susceptible. The Triumph and Red Brazil are both vigorous varieties but the former is not attacked as severely as the latter. The Porto Rico strains of moist, soft texture and the Jersey strains of dry, firm texture are highly resistant. On the other hand the Nancy Hall of the moist type and the Red Brazil of the firm type are severely attacked. The Jersey and Nancy Hall varieties both develop potatoes close to the stem, but the former is resistant and the latter very susceptible to infection. Details of this study are given in Bulletin No. 265, "The Nematode Disease of Sweet Potatoes."

LIMITING FACTORS OF FUNGUS GROWTH

In studying the growth of *Fusarium batatatis*, *Fusarium lycopersicii*, *Fusarium conglutinans* and *Fusarium vasinfectum* on media prepared synthetically and with different plant products, it was shown that a sweet potato medium containing 250 grams sweet potato, 15 grams agar and 1,000 c.c. tap water is well suited for differentiation of these organisms. The growth behavior and the pigmentation of all four organisms were clearly distinct. *Fusarium batatatis* did not darken the substances of any medium used. On rice the fungus pigment color varied from mallow to aster purple. On corn meal it was shades of pink to dull dark purple. On cane sugar the color was dark madder violet. On Cook's synthetic medium there was a copious growth of white mycelium which gradually became purplish, being near mathews purple. On hay infusion, sweet potato stems, crab grass and barnyard manure the mycelium remained white. On beef extract, the growth was very weak and light in color. Microspores were most abundant on plant parts. Macrospores predominated on media prepared synthetically and with plant decoctions. Clamydospores were abundant on all media. Spore forms and measurements were slightly variable for the different media. Inoculation of susceptible varieties with microspores, microspores, and the mycelium gave the same amount of infection.

In studying the life history of the organism in different soil types, the results indicate that sandy soils are well suited to maintaining the life of the fungus. This fungus apparently does not live over on clay and heavy loamy soils, because infection did not occur during 1929 when plants were transplanted in these soils inoculated during 1928. It did take place on sandy soils inoculated at the same time. Previous tests had shown that the susceptible varieties became infected and wilted badly when inoculated and set in all soils. The virulence of the organism has been maintained without change on a sweet potato medium since 1925. While the Triumph and Red Brazil varieties continue to show high resistance to infection, a greater percentage of wilt is obtained in inoculating these varieties now than was found in other years.

The *Monilochaetes infuscans* grew well and very uniformly on all plant parts including rice, corn meal, Irish potato, sweet potato and dextrose media. Growth was slow on beef extract and cook's synthetic media. On both barnyard manure and hay infusion the fungus grew slowly but abundantly. Spores were produced on all media.

Further studies on the relations of fertilization to susceptibility of infection indicate that such relations are physiological. Fertilizers such as nitrates which have some influence in bringing about cracking of potatoes just before harvest makes an entrance possible for *Ceratostomella fimbriatum*. On the other hand, manures and leguminous crops furnish a favorable medium for the scurf organism, *Monilochaetes infuscans*, and as a result the disease is worse than where the growth of the fungus is less abundant.

PREVENTION OF FIELD INFECTION

The causal organisms of stem rot, black rot and scurf, the three important diseases of sweet potatoes, are seed bourne. They remain on the potato during storage and later attack the sprout, spreading to it from the potato. Besides being seed bourne, these organisms live over in the soil, where infection may occur at any time during the growing season. The causal fungus of stem rot, *Fusarium batatatis*, is widely distributed in sandy soils, so that contamination of plants takes place during the transplanting period. In the fifty-first Station report and later in Technical Bulletin number 35 from this Station the results were given for a successful control of the disease by applying Bordeaux mixture to the stems just before transplanting. Later tests resulted in excellent practical control. This part of the project is satisfactorily completed, but similar tests are being conducted for the control of scurf and black rot. Further studies on stem rot control may be continued because a single chemical may not give efficient control of all three diseases, and combined chemicals or a mechanical mixture of several chemicals may be obtained for the control of all three by a single application.

The scurf organism, *Monilochaetes infuscans*, does not attack the conductive tissues. It is superficial and sub-epidermal because it slightly penetrates the cortex of the stem, roots and potato. The spores in large numbers are produced throughout the growing season on the stem and roots. Dissemination is downward by gravity and water, and in all directions by a gradual spread of the mycelium. Cracking of the soil around the hill as a result of

the enlargement of the potatoes is an aid to the dissemination, since the spores are more readily washed downward through the cracks. The dissemination upward and laterally was greatest on fertile soils and very weak on light sandy soils. The evidence shows that the common practice of taking plants from the plant bed and puddling them is a ready means of contamination even when a small percentage of plants are infected in the beginning. Dipping plants in bunches in the same water just before transplanting resulted in heavy infection even when only one per cent of the plants were diseased.

The treating of plants with various chemicals just before transplanting was conducted in a manner similar to that described for the control of stem rot. Diseased plants were treated to determine the effectiveness of substances used as a preventive measure for the fungus developing on the stem and spreading from the infected stem to the potato. Healthy plants were inoculated with spores from a pure culture of the fungus and then treated to determine the complete controlling value of the substance used.

In these tests the copper lime compounds gave negative control, and seemed to actually increase the severeness of the disease especially when weaker strengths were used. The organic mercury, (Semesan Bel) reduced the infection but did not control the disease in this and other tests, even when a strength of 1-5 was used. Finely ground sulfur greatly reduced the infection of potatoes and plant infection amounted to 4.3 per cent in comparison to 100 per cent of check plants. These results were easily obtained, even though the roots and stems of all plants were already diseased when transplanted in the field, because the tissues on plants where the fungus growth was not checked were more deeply browned, somewhat rough and infections on potatoes and prominent roots. When the fungus was arrested, the tissues were very light in color and smooth with no further spreading of the fungus along the potato stems. The infection of potatoes on sulfur treated plants was 1.7 per cent in comparison to 67.2 per cent on check plants. There was no soil infection since the healthy check plants remained healthy and produced potatoes with no scurf. In other tests healthy plants were inoculated with spores of *Monilochaetes infuscans* and treated with the same chemicals used for treating diseased plants. In these tests the control was slightly better than where diseased plants were treated. Even Bordeaux paste gave some control in these tests.

DISINFECTION STUDIES CONTINUED

In previous reports it was shown that the scurf disease of sweet potatoes caused by *Monilochaetes infuscans* was not satisfactorily controlled with chemicals now recommended and when used in stronger amounts and for longer periods for treating sweet potatoes. Further tests were conducted with various chemicals again this year because other means of applying the chemicals had not been investigated. This study was on the use of stronger mixtures, longer periods of treatment, higher temperatures and presoaking before treatment on the control of the scurf fungus. Freshly harvested potatoes were also treated with various mixtures before the tissues had sufficient time to dry and harden to the condition predominating at the time of bedding.

Badly scurfed potatoes were soaked for 6 and 18 hours in water and then treated in the ordinary way with mercuric chloride 1-1000 and Formaldehyde 1-100; after which the potatoes were bedded in the usual way. The first plants were examined eight weeks after treatment. Others were examined at various periods because it was an excellent means of discovering weak infections that could not be detected in the earlier examinations.

After soaking the potatoes 18 hours the hard, dry calloused tissues were soft and the other tissues had absorbed water to the extent that some cracked. The desired condition was developed since the object in treating presoaked potatoes was to determine if the chemicals would penetrate the mycelium imbedded in the tissues. It was found in previous tests that the imbeded mycelium in the hard dry tissues was not penetrated by the chemicals during the length of time in which the potatoes could be treated without serious injury to germination. In these tests mercuric chloride retarded the infection by June 1 when the commercial planting was made, but by August 1 the total infection was practically the same on all treated potatoes and on the untreated. However, there was a greater degree of infection on untreated and Formaldehyde treated potatoes than on mercuric chloride treated potatoes.

Treatments similar to this with Lysol, Phenoco, Potassium Permanganate, Bordeaux mixture, and Semesan gave the same results as noted above. Longer periods of treating with these chemicals also gave negative results. On the basis of the scurf disease, the presoaking, which was repeated five times with three applications of each treatment with Yellow Jersey and Nancy Hall potatoes offers no helpful control. On the other hand presoaked potatoes, especially those that were badly dried out, germinated much more uniformly and produced more plants than those that were not soaked. But untreated presoaked potatoes were decayed by soft rot producing organisms more severely than potatoes bedded dry.

The object in using hot water was to secure greater penetration. These treatments, conducted at 50 degrees centigrade, were varied from 2 to 15 minutes. Up to five minutes treatment no injury occurred but longer treatments caused retarding of germination. The mercuric chloride solution heated to 50 degrees and used for 2 and 5 minutes slightly retarded the fungus but did not control the disease. Formaldehyde and untreated check plants were equally and badly scurfed. Similar tests were conducted with organic mercury, copper, sulfur and calcium compounds, but in no case did the higher temperature assist in increasing the control efficiency of the chemical used. Furthermore the hot water alone had no effect on the fungus.

For the third consecutive year tests were conducted with mercuric chloride 1-200—1-500 and 1-1000 and Formaldehyde 1-100 and 1-240 for treating badly scurfed potatoes for 5, 10, 15, 30, 60, and 120 minute periods. The Yellow Jersey and Nancy Hall varieties were both used in the tests conducted this year. A double check was obtained on the plant infection, first by examining the plants when pulled for transplanting and after the crop was harvested. Two different lots of plants from each treatment were used for laboratory examination and field plantings because of a probable contamination taking place during the examination of sprouts. Formaldehyde did not reduce the infection but caused injury to potatoes soaked for 120 minutes. Mercuric chloride retarded infection when the treatment was for only five minutes

and slightly more reduction of infection was produced as the length of treatment was extended. But all treatments with mercuric chloride retarded germination. There was no germination of potatoes treated for 60 and 120 minutes. The 15 minute treatment, although reducing sprouting slightly more than the 10 minute treatment, has consistently given greater reduction in infection, and is suggested as preferable to the shorter period of treatment for practical applications. However, it is quite evident from these results that mercuric chloride does not give an altogether practical solution of the scurf problem even if there was no detrimental effect on germination.

It was shown in previous tests that organic mercury compounds used in heavy dust and paste treatments controlled the scurf disease in that they prevented the fungus from spreading from the diseased potato to the plant, but in every case the heavy treatments so greatly reduced sprouting as to prohibit their use for practical purposes. Further tests were conducted with other dust compounds such as copper and sulfur mixtures, with different solution strengths of the organic mercury compounds and with combinations of organic mercury with sulfur, dolomite and copper lime dusts in which the percentage of mercury was varied from 3 to 20 per cent. Copper lime dust (25 per cent monohydrated copper sulfate) slightly reduced scurf. Sulfur gave some control. Neither of these compounds reduced germination when applied to dry potatoes but did injure sprouting when applied to wet potatoes. The organic mercury greatly retarded sprouting in all strengths where dolomite was used as a base. Where copper lime was used as a base for the organic mercury compound the sprouting was slightly reduced for all strengths but slight reduction of the disease was obtained. Greater control was obtained when sulfur was used as a base. When the organic mercury compounds were used in dillutions of 1-5, 1-10, and 1-20, sprouting was greatly retarded following the treatment with the 1-5 strength and some times with the 1-10 strength. Although these treatments retarded scurf, even the strongest solution did not prevent the fungus from spreading from potato to sprout in a manner similar to the dust and paste applications or prove satisfactory for a practical control.

When harvested, potatoes both badly scurfed and free from scurf are equal in weight. During storage scurfed potatoes shrink badly and lose much more in weight than potatoes free from scurf. The outer infected tissues of scurfed potatoes, especially the upper ends, are mostly hardened and in many cases completely dessicated by the bedding period in March and April. In previous tests it was shown that treating diseased potatoes with a mercuric chloride solution of 1-1000 strength for 15 minutes would give some control of scurf when the potatoes were slightly infected so that there were only a few spots and very slight or no shrinkage. These facts suggested the possibility of controlling the disease by treating the potatoes immediately after harvest as a means of controlling the disease before the tissues were hardened and the fungus protected. Badly scurfed potatoes treated with 10 per cent organic mercury dust, mercuric chloride 1-1000 for 15 minutes, and sulfur dust all greatly reduced the infection of sprouts without retarding germination when the potatoes were bedded immediately after the treatments were made. Lysol, Phenoco, Potassium permanganate, copper lime dust, lime, Bordeaux mixture, calphene, and Formaldehyde gave negative results.

In previous tests sand obtained from wash areas was used. While this medium was entirely satisfactory for bedding the potatoes, as was shown by the healthy condition of the check plants two other media were used with much satisfaction this year. Pine saw dust was found to be an excellent medium when drainage was furnished. Ashes from a semi-anthracite coal proved to be an excellent medium. Sprouting was more uniform and less soft rot occurred than in sand cultures. It also gave a sterile medium that was always an uncertainty when sand is used.

DEWBERRY DISEASE STUDIES

The ripening season and the pruning of old canes this year were from two to three weeks later than in average seasons. Cutting the canes later than usual along with wet and unfavorable conditions for the development of new canes resulted in very poor cane wood for the 1929 crop. On the other hand anthracnose did not attack the leaves and canes until thirty days before the ripening of the 1929 crop. A heavy application of Bordeaux immediately after the vines were tied up in March, and another thirty days before ripening in June did not control the disease. The latter spray was also detrimental to the best market value of the crop, since much Bordeaux deposit remained on the berries. The disease was economically reduced by cutting and destroying old canes. The irregularity of seasonal infection due to unfavorable conditions for the development of the fungus was found to be a definite aid in controlling the disease.

The treatment of plants infected with *Collybia dryophila* with chemicals as was discussed in previous reports did not result in a practical control of the root rot. Treating young plants with chemicals including copper, sulfur, mercury, calcium, and formaldehyde compounds resulted in very irregular stands. The dewberry plant is difficult to successfully transplant even under the most favorable conditions, and retarding the growth of roots seemed to occur where every chemical was applied. The weakest strengths of all chemicals used caused some injury.

Selections were obtained from strong, healthy plants in fields where this disease is severe. These were planted on infected soils for further studies to determine if they are resistant to the disease. Already selections from some of the strongest plants show greater vigor than those from weaker plants. Further selections are being obtained from the vigorous plants, because very few plants were obtained in the first selections. The young variety planted in the same field shows marked superiority of growth and greater vigor than the Lucretia but its reaction to the root rot will not be known for some time.

Cane blight due to *Leptosphaeria coniothyrium* is an important and common disease of dewberries in the commercial plantings of the sandhills. This disease was found in all fields and the infection varied from 15 to 100 per cent. It is worse in fields where old canes are cut above the ground so that the cut tissues are left exposed. The fungus gains entrance to the tissues through the freshly cut areas. It works downward finally extending below new canes which wilt and die. This frequently results in heavy loss during the ripening period because berries on wilted vines dry up and become unsalable. The disease does not kill the plant, for the fungus either works slowly or not at all beneath the soil. Plants on which the old canes were removed just beneath the soil were found to be free from the disease in many

fields. The canes on these plants were more uniform in length and vigor than on plants pruned above ground. Experimental tests this year indicate that cutting the canes just beneath the soil is a practical means of controlling the disease and developing greater uniformity of cane growth.

The small black pycnidial bodies with masses of spores were found on the dead parts throughout the year. This imperfect stage is all that the fungus needs in this climate to carry the disease over from one year to another. The perfect stage, which is rarely seen, was collected in several fields during March and April. It was found on wood killed during the previous season.

PLANT ECOLOGICAL FEATURES OF THE SANDHILLS

B. W. Wells and I. V. Shunk

In this report, "sandhills" is used in a brooder sense than that of the aggregation of high sandy hills of Moore, Cumberland, Hoke and southern Harnett counties. This project covers the major problems presented by the vegetation and habitat of the uplands in the coastal plain, which are characterized by medium to coarse sandy soils.

The organization of the vegetation of which wire grass (Aristida stricta) is the characteristic herbaceous dominant and indicator of the habitat, has been completed. At least three consocies may be readily distinguished and practically complete lits of the dominants, subdominants and minor elements have been obtained. The later in this type of habitat are of very great importance in differentiating the areas of slightly varying water conditions, hence their emphasis in our studies. Certain striking xeric structural adaptations observed in the vegetation have been observed and described.

Of especial interest are the studies of roots prosecuted uring last summer. Many different types of root systems were found occupying different layers of the soil.

Field habitat studies have been chiefly directed to the fundamental water relation and studies made of the critical factor of the water supplying power of the soil, using the Livingston soil points. This work during the past season was prosecuted more intensively than before in spite of a rather unfavorable year of high precipitation. The local area under observation was near Spout Springs, in southern Harnett County.

Measurements of other back ground factors which have a bearing on the water conditions, have been made. These include local precipitation, soil texture, local topography, temperature (particularly the high temperatures of the soil surface) and evaporation. The picture presented from our results indicate a rapidly falling water supplying power of the soil which during interrain periods of even moderate length may reach a critical point for many mesic plants. Since this is equally true of crops, all of our work has an important bearing agriculturally.

Laboratory studies, dealing with the organic matter of a typical sandhill soil, together with the microflora content are in progress. Measurements of total N. nitrates and ammonia have been made.

PLANT PHYSIOLOGY INVESTIGATIONS

D. B. Anderson

Cell Wall Studies

Studies of cell wall structure in cotton fibers were continued during the past season. Cotton fiber structure has been studied with the aim of determining the relation between the method of fiber formation and the structure and behavior of mature fibers. Satisfactory correlations have not been established and the work is being continued. The problem presents unusual difficulties in the way of technique and interpretation.

As a part of a general study of the relations existing between epidermal cell wall structure and the resistance of plants to water loss and to the attacks of parasitic fungi two studies have been made.

An explanation of the peculiar growth habit of Deplocarpon rosæ in the epidermal wall of rose leaves has been discovered by a micro-chemical investigation of the structure of this cell wall. The results of this research were reported at the last meeting of the N. C. Academy of Science.

Effect of Dusts on Peanuts

Studies of the effect of various dusts upon the rate of transpiration in peanuts are underway. Through the use of automatic recording apparatus the rate of water loss from dusted and undusted plants has been measured. These results are being correlated with microchemical studies of the epidermis to determine possible penetration of the dusts to the interior of the leaf. This work is still underway and will be extended to include the effects of sprays and dusts upon the water relation of other crop plants.

B. W. Wells,
Head, Department of Botany

RESEARCH IN HORTICULTURE

The experimental work of the Department of Horticulture may be grouped conveniently according to crops, as tree fruits and nuts; small fruits; vegetable crops; and floral crops. Experimental methods and proceedures applicable to solutions of the problems encountered in the various branches of the industry and arising primarily from factors of soil, climatic, culture or adaptation in North Carolina are employed.

Physiological studies are necessary and often invaluable in interpreting the changes or conditions accompanying abnormal plant behavior or in determining the effects of certain cultural practices. Such studies correlated with the observed behavior often form the foundations for a more logical and practical suggestion leading to a modification of prevalent practices. Such studies are at present being conducted among which is a study to determine the relation between the chemical composition of peach trees in different conditions of vigor or thrift and their susceptibility to winter injury. The results of this study alone amply justify the method. Other studies are under way or are contemplated which not only have a distinct practical bearing but may add to the growing fund of knowledge of plant behavior and response fundamental to the advancement of agriculture.

Plant breeding methods are being applied to secure better quality, yield, adaptability, disease resistance and the like in several of the horticultural crops where the problem is capable of solution by these means. Permanent improvement and distinct advances in agriculture are in a large way dependent on originating or securing in other ways the varieties best adapted to given regions.

Extensive variety testing of most of the more important horticultural crops is under way. In addition extensive tests of species and varieties of horticultural plants secured through the Office of Seed and Plant Introduction are being conducted. Such work is invaluable in determining the best varieties to be grown in the major commercial districts of the state as well as for home use. Not only are such tests valuable in determining the merits of a variety but also in finding and having available plants with one or more desirable characteristics that may be used in plant breeding work.

Extensive experiments are being conducted at the various branch stations to determine the effect on yield and quality as well as other characters of the plant of such cultural practices as fertilization, spacing, rate of seeding, pruning, thinning and the like. The most profitable practice from the standpoint of yield and quality may be determined only in this way.

APPLE INVESTIGATIONS

Apple Pruning and Training, M. E. Gardner, Leader.

An apple pruning study was begun at the Mountain Station in 1919 to determine the effect of the amount of annual pruning on earliness of bearing and productivity, and to contrast the open center and modified leader methods of training and the comparative value of high and low heads.

The experiment has been continued as outlined in previous reports. The different degrees of pruning have been followed consistently and the effects on yield, color, growth response of the tree such as trunk diameter, weight of prunings, breakage of limbs and other notes have been taken. Indications give preference to trees headed thirty-six inches when planted and trained according to the modified leader system. The low hanging limbs on the trees headed at twenty-four inches and lightly pruned are especially troublesome both from the standpoint of cultivation and harvesting. There has been a small amount of trunk splitting on Delicious trees headed thirty-six inches and trained to an open center.

The yields according to variety during the past year all indicate a decided correlation favoring the light pruning which together with reports from other stations definitely indicate that light pruning on apples is distinctly to the growers advantage.

Variety	Average Yield in Bushels per Tree		
	Heavy Pruning	Medium Pruning	Light Pruning
Rome	.94	1.00	2.10
Winesap	1.30	1.78	2.29
Stayman	2.70	4.95	5.34
Delicious	1.90	3.89	7.06

Apple Fertilization, M. E. GARDNER, Leader.

The purpose of this experiment, begun in 1924, is to determine the effect of different fertilizer elements, alone and in combination, on growth and yield of the apple.

The experiment is divided into fifteen plots and contains fifty-eight Delicious and fifty-eight Bonum trees.

Due to the natural richness of the soil at the Mountain Station, no very marked differences in growth are apparent that may be ascribed to the fertilizer applications. Neither have the trees borne sufficiently to make a report on yields.

Summer Apples, ROBERT SCHMIDT, Leader.

The block of summer apples at the Coastal Plain Branch Station had so far succumbed to disease and insect attacks that this project has been discontinued for the present. Plans are already under way to reëstablish it, however, as soon as the land may be cleared up and the soil gotten into condition. Seedling trees and varieties from a number of locations in the Coastal Plains and from states farther South are being propagated at the Central Station. Varieties and species recommended by the S. P. I. are also being secured. The object is to secure plants, that are most likely to survive under the conditions at the Coastal Plain Station, for stock and breeding studies.

Apple Storage, M. E. GARDNER, Leader.

The operation of the air cooled apple storage house constructed in 1926 at the Mountain Station was again checked by means of the hygrothermograph. The temperature and humidity records indicate that if the house is given consistent attention that optimum storage conditions can be maintained. Results of storage tests on the fruit have, however, been inconsistent due to storage fluctuations. It is planned to control these fluctuations and to attempt more detailed studies such as stage of ripeness, degree of color, effect of fertilizer treatment, humidity and temperature in relation to the storage life of the fruit.

PEACH INVESTIGATIONS

Peach Winter Injury, C. F. WILLIAMS, Leader.

The purposes of this project are twofold, first to study the relation of the condition of the tree to its susceptibility or immunity to winter injury, and second to study the relation of the factors of soil fertility and management to winter injury. Because trial plots have not been through a severe winter and no methods of artificial freezing are available, actual test of the efficacy of any of the treatments has not been secured. The winter of 1928-29 was especially mild and no killing occurred among trees under observation. However, trees receiving summer applications of nitrate of soda continue to make better yields and growth and maintain a better vegetative condition later in the season and show greater vigor in the spring. Physiological data on the relation of the condition of the tree to its susceptibility are being secured. The cool, wet spring and rainy summer resulted in heavy defoliation by bacteriosis. This will be an additional factor to consider in this year's results.

Present recommendations based on orchard surveys, test plots and data secured would be:

1. That only favorable sites as regards location and soils be selected. Situations of poor or excessive drainage and sand that is coarse or low in humus should be avoided.

2. That the organic matter in all the Sandhills soils be increased to make them more retentive of both water and fertilizer. Probably this can be done best with winter legume cover crops.

3. That orchards be maintained in good condition and vigor throughout the entire year. This includes control of insects and diseases, and proper fertility. Any factor that weakens the tree will make it more susceptible to winter injury.

4. That where trees have been weakened by bacteriosis, defoliation, heavy crops, insufficient fertilization, etc., that they be given an application of nitrogen in mid-summer or after harvest. Trees should continue to be vegetative until October. This will insure their going into the winter season in better condition, will probably delay the rest period until later in the winter and in this way avoid the late winter injury commonly observed.

Peach Thinning Improves Size, M. E. GARDNER, Leader.

Peach investigations have been under way for a period of years not only to determine the importance and value of certain orchard operations

under the soils and climate of the locality, but also for study and observation by the commercial grower.

The results of peach thinning tests conducted at the Piedmont Station prove conclusively that thinning increases size and marketability of peaches.

Georgia Belles were thinned two, four, six and eight inches apart soon after the June drop.

Yield, quality, and condition seem to show that a spacing four to six inches between fruits gave the best results.

Unthinned Hileys were so small that they brought a very low price, whereas a premium of from twenty-five to fifty cents per bushel was realized from thinned fruit.

The cut shows peaches from thinned and unthinned Georgia Belle trees. The basket on the left was picked from a tree that had been thinned to six inches. This is tree run fruit and the top fairly represents the rest of the fruit in the baskets.

Peach Pruning, M. E. GARDNER, Leader.

This experiment was begun at the Piedmont Station in 1923 for the purpose of determining the effect of heavy and light pruning on tree performance.

The lightly pruned trees continue to give larger yields, better color and reduced pruning costs. The treatment on these trees has consisted of light thinning and removal of broken and intefering limbs.

On the heavily pruned trees, heavy thinning and heading of one year wood has been practiced and has resulted in such rank foliage and dense growth that the fruit is invariably shaded so that poor color has resulted. The bearing area is materially restricted on these trees and lower yields than those obtained from less severely pruned trees have resulted.

Peach Breeding, J. H. BEAUMONT, C. F. WILLIAMS, Leaders.

The peach varieties originally secured for breeding purposes have been considerably augmented and have been transferred to the college grounds of the Department where a large collection of the better and newer varieties is being grown. These should be tested in the Sandhills, the most important peach district, but land and other facilities are not available there. It is hoped that extensive self and cross pollinations may be made during the coming season and that land will become available in the Sandhills to grow the seedlings and to study them for disease resistance, period of ripening, and commercial characteristics such as growth and yield of tree and carrying quality of fruit.

Peach Fertilization in the Piedmont, M. E. GARDNER, Leader.

In 1923 twenty-five trees, including five varieties, were set apart to determine the effect of nitrate of soda on the growth and yield of peach trees in comparison with trees of the same variety receiving no nitrogen whatever. To date the trees receiving no fertilizer have made fair growth and but three out of the twenty-five have died. The loss of these three cannot be attributed directly to lack of nitrogen as other causes contributed. Trees receiving an annual increase of about eight ounces of nitrate of soda have maintained vigor and production without the use of the other fertilizer elements. The no nitrogen trees have shown a steady decrease in vigor but this decrease has not been as marked as might be expected on other soils.

The strong Cecil clay loam soils of the Piedmont section of the State are well adapted to the growing of peaches and indications are that nitrogen may possibly be the only element necessary to maintain growth and production of peach trees grown on this soil type.

Some comparisons in yield of the trees during the past year are given in the following table:

Variety	Average Yield per Tree (Bushels)	
	Nitrogen	No Nitrogen
Hiley	3.60	1.70
Belle	2.50	2.00
Elberta	3.43	1.65
Hale	3.30	1.75
Augbert	1.50	.94

Fruit and Nut Variety Test Studies, M. E. GARDNER, J. H. BEAUMONT, Leaders.

Every year new fruits are being developed and others that have passed the experimental stage are introduced into the nursery trade and are sold to growers and others. In order to determine the value of new and noteworthy fruits under North Carolina conditions, tests have been under way and others started during the past season at the Central Station and at the Piedmont and Mountain Branch Experiment Stations.

During the year scion wood of seventeen of the newest varieties of apples and cuttings of thirty-seven seedling grapes were received and propagated for these studies. This material was received from other experiment stations and from nurseries or private plant breeding grounds. Within the State, several promising apples, pears, black walnuts and pecans have been located and will be propagated.

Coöperating with the Federal Office of Foreign Seed and Plant Introduction, this Station received eight different kinds of fruits representing twenty-seven varieties. These introductions are to be tested under the climatic and soil conditions existing in the State. Ornamental trees and shrubs as well as bulbs and other flowering plants are also being tested extensively.

Tests begun the past season at the three stations mentioned above include the following:

Peaches	17 varieties
Cherries	9 varieties
Small Fruits	36 varieties
Grapes	40 varieties

These plantings will be added to from year to year and records kept on varietal characteristics.

PECAN INVESTIGATIONS

The pecan investigations of the Department are of considerable age and are now reaching the stage when a final report may be prepared. A preliminary report of the Pecan Variety Test, being conducted at Willard, was prepared by Mr. C. D. Matthews, former Horticulturist of the Station, and will doubtless appear in the Proceedings of the National Pecan Growers Association. Other reports are in process of preparation and may be consolidated in bulletin form.

Pecan Cracking Test, R. SCHMIDT, M. E. GARDNER, Leaders.

Cracking tests of the more important varieties of pecans have been made consistently since the varieties came into bearing in 1915. These results are being summarized and will be published as a final report of this project. Together with yield and quality the cracking test gives a very good indication of the commercial possibilities of a variety. A summary sheet of the behavior of 12 of the 24 varieties under test is given. These results are not significantly different from the results in previous years.

Pecan Breeding, R. SCHMIDT, Leader.

Thirty-nine trees in the seedling grove, planted from nuts of the Schley, bore nuts in 1928. Of these all but four were discarded and the trees removed as being of no value. The others were saved for further observation. As yet no seedlings of outstanding merit have been produced in this grove.

Pecan Variety Tests, R. SCHMIDT, Leader.

The crop at the Upper Coastal Plain Branch Station was almost a total failure on account of adverse weather conditions. At the Lower Coastal

Plain Branch Station the average yields per tree of the principal varieties were as follows:

Schley	13.3 lbs.
Stuart	6.2 lbs.
Van Deman	9.5 lbs.
Money Maker	97.8 lbs.
Frotscher	16.7 lbs.
Curtis	24.7 lbs.
Alley	26.5 lbs.

It must be kept in mind that most pecans are biennial bearers and therefore comparisons of varieties cannot be made on one or two years results.

Variety	No. Nuts per pound	No. Unbroken Halves	No. Broken Halves	No. Shrunken Halves	No. Faulty Nuts	No. Physiol. Spots	Wt. Meat ozs.	Per cent Meat	Empty Nuts
Pabst	56	112	0	4	0	0	7.7	48.3	0
Schley	57	113	1	2	0	0	10.0	62.5	0
Alley	65	126	0	3	0	2	9.2	57.5	2
Teche	78	152	4	3	2	3	7.5	46.8	0
Van Deman	64	98	30	7	0	0	7.5	46.8	0
Frotscher	62	124	0	0	0	0	8.5	53.1	0
Success	48	93	3	2	0	6	8.5	53.1	0
Curtis	85	154	16	2	0	0	9.6	60.0	0
Centennial	68	109	27	0	0	2	7.9	49.5	0
Louisiana	72	111	31	0	0	0	7.6	47.5	1
Moneymaker	68	136	0	2	0	0	8.0	50.0	0
Stuart	53	100	6	4	0	0	7.8	48.7	0

Pecan Orchard Management, R. SCHMIDT, Leader.

The purpose of this project is to determine what effect clean culture, use of cover crops, and sod culture will have on the yields of pecans. The project is located at the Upper Coastal Plain Station and as the crop was a failure, no results can be noted.

SMALL FRUIT INVESTIGATIONS

Dewberry Breeding, C. F. WILLIAMS, Leader.

Dewberry crosses of 1927 fruited for the first time this year. Crosses of Young x Lucretia gave some promising seedlings exhibiting characters of

greater firmness of fruit than found in either parent. Many were of good quality. The 1929 season was especially favorable for the development of anthracnose and septoria so that it was possible to make selections for resistance to these diseases. Seedlings ranged in infection from slight to severe injury.

The most interesting seedlings resulted from crosses of Young x Austin Thornless. Thornless offspring occurred in the F_1 generation, one of them being quite prolific and showing good vine and fruit characters. This is being propagated for trial and further breeding at the Station. The greatest value of this seedling lies in the fact that now it will be possible to breed for the thornless character and for good vine and fruit qualities as well. This is the first thornless cross that has given fertile offspring.

Dewberry Culture, C. F. WILLIAMS, Leader.

The crop of 1929 was very short due to the poor development of canes in the late summer of 1928. This lack of growth and resulting low yields interfered seriously with all investigational work especially that in regard to summer pruning and fertilizer requirements. The lack of growth was probably associated with the excessive rains of August and September, 1928, resulting in either a water injury or a leaching of fertilizers. With the peculiar season vines fertilized in late summer after the rains made a better growth than those not receiving such applications.

Strawberry, Study of Yield and Quality as affected by different fertilizers, R. SCHMIDT, J. H. BEAUMONT, Leaders.

The first year's results following the reorganization of the project indicate that no significant differences have become apparent that may be directly ascribed to the fertilizer treatments. Ununiformities in the field have developed that are undoubtedly due to the soil and to washing. These may be of such nature that certain plots may have to be discarded, while in other cases a fair average may be obtained by harvesting measured portions of the rows.

Notes on rots, developing after transit, size and grade of berries, size and apparent vigor and yield of plants as well as the number of missing hills were recorded and will be correlated with similar observations next spring to determine the effects of fertilizers on these characters.

Strawberry Variety Test, M. E. GARDNER, Leader.

Seventeen varieties are included in the strawberry variety test at the Mountain Station and additional varieties were added which have not yet fruited. Some of the less adapted sorts have been discontinued.

Warfield and Premier (Howard 17) continue to show highest yields and greatest resistance to disease.

Following one or more years' results it will be possible to make specific variety recommendations for the western part of the state.

VEGETABLE INVESTIGATIONS

Effect of Spacing on the Yields of Irish Potatoes, R. SCHMIDT, Leader.

This experiment has been carried on in an endeavor to find out the optimum planting distance for Irish Potatoes. Results for different years

show that weather conditions are large factors in the variations of yields of the different plots. The results for the spring season of 1929 are given in the following table, and indicate that, with the abundant rainfall this season, the closest planting distances 2½ ft. x 9 in. and 2½ ft. x 12 in. gave the highest total yield and the greatest weights of No. 1 tubers. Apparently this year the percentages of No. 1's did not vary greatly in any of the planting distances. These records are in general accord with previous years results. This experiment will be run again, however, in order to accurately determine the effect of climatic and spacing conditions on yield.

EFFECT OF SPACING ON YIELD OF IRISH POTATOES*

Plot	Ft. Row	Area	Yield per Acre—Bu.		Total Yield per Acre Bushels	Per Cent No. 1
			No. 1	No. 2		
2½ ft. x 9 in.	50	1 A / 348.5	278.8	87.1	365.9	76.2
2½ ft. x 12 in.	50	"	316.5	101.6	418.1	75.6
2½ ft. x 15 in.	50	"	267.2	69.7	336.9	79.4
2½ ft. x 18 in.	50	"	174.3	46.5	220.8	78.9
3 ft. x 9 in.	50	1 A / 290.4	242.0	63.0	305.0	79.4
3 ft. x 12 in.	50	"	208.2	77.5	285.7	72.8
3 ft. x 15 in.	50	"	232.4	43.6	276.0	84.3
3 ft. x 18 in.	50	"	176.7	50.8	227.5	77.6
3½ ft. x 9 in.	50	1 A / 249	207.5	85.1	292.6	70.9
3½ ft. x 12 in.	50	"	203.4	60.2	263.6	77.1
3½ ft. x 15 in.	50	"	161.9	72.6	234.5	69.0
3½ ft. x 18 in.	50	"	151.5	43.6	195.1	77.6
4 ft. x 9 in.	50	1 A / 217.8	141.6	67.2	208.8	67.8
4 ft. x 12 in.	50	"	172.5	59.9	232.4	74.2
4 ft. x 15 in.	50	"	145.2	59.9	205.1	70.8
4 ft. x 18 in.	50	"	127.1	41.8	168.9	75.3

*Planted—March 15, 1929.
Harvested—June 20, 1929.
Lower Coastal Plain Station, 1929.
Variety—Irish Cobbler.

Effect of Source of Seed on the Yield of Irish Potatoes, R. SCHMIDT, Leader.

Maine has always been the chief source of Irish Potato seed for the early crop in this State. Other sections are now growing seed potatoes in competition with Maine to supply the seed in the early potato region. The purpose of this experiment is to determine the value of seed from such sections as compared with Maine seed. The following table gives comparative yields of seed from Maine and Prince Edward Island, Canada, this year.

EFFECT OF SOURCE OF SEED ON YIELD OF IRISH POTATOES

Source of	Area	Yield per Acre—Bu.		Total Yield per Acre Bushels
		No. 1	No. 2	
Maine	1 A / 47	188.0	59.7	247.7
Canada	1 A / 47	229.2	62.7	291.9

Planted—March 15, 1929.
Harvested—June 20, 1929.
Lower Coastal Plain Station, 1929.
Variety—Irish Cobbler.
Rows 3 ft. apart. Hills 12 inches apart.

The difference of 44 bu. or 15% in favor of the Prince Edward Island seed may not be said to indicate a true difference since it is a relatively small test and will be carried out again. Tests in successive years will prove conclusively whether there is any real difference in yielding ability between the seed of these sources.

SWEET POTATOES

Strain Selection of Sweet Potatoes, R. SCHMIDT, Leader.

The purpose of this project was to determine if seed sweet potatoes could be improved in yield and quality by hill and tuber selection. A strain of Porto Rico potatoes has been developed by careful selection that has shown from 20 to 35 per cent greater yields than common seed and appears to be much smoother. Tests during the season of 1928 gave increased yields of approximately 25 per cent. Results of one of these tests are shown in the following table.

14—8

COMPARISON OF IMPROVED STRAIN PORTO RICO WITH COMMON STOCK
56 lbs.=1 bu.

Plot	Area	Yield —lbs.			Yield per A.—Bus.			Total Yield per Acre—Bus.
		No. 1	Jumbo	Cull	No. 1	Jumbo	Cull	
Improved Strain	1 / 40 A	279.0	211.0	28.0	199.28	150.71	20.00	369.99
Common Stock	1 / 40 A	253.0	115.0	29.0	180.71	82.14	20.71	293.56

Harvested—10-30-28.
Edenton, N. C., 1928.
(Farm of Mr. Webb.)

NOTE—Plants set at same time, fertilized and cultivated alike.

These results together with those previously published impress the fact that the improved strain, particularly when secured from a certified source, will materially increase the yields over ordinary seed stocks.

Sweet Potato Fertilizers, R. SCHMIDT, Leader.

The primary object of this project is to find out what effect increased amounts of potash have on yields of sweet potatoes. Two years work at the Upper Coastal Plain Station indicated that up to 8 per cent of potash the yields increased noticeably. At the Lower Coastal Plain Station, however, a four year average gave no appreciable gain for 6, 8, or 10 per cent potash over 4 per cent.

The 8-3-4 fertilizer formula for sweet potatoes in the Coastal Plain is, therefore, recommended because of these results as well as from other work.

Effect of Maturity, Frost and Late Digging on the Keeping Quality of Sweet Potatoes in Storage, R. SCHMIDT, Leader.

It is a general custom of our growers to dig their sweet potatoes after the frost has killed the vines. It was the purpose of this experiment to determine what effect this late digging had on the keeping of the sweet potatoes in storage. The following table gives an average of five years results giving approximate digging dates and per cent of loss in storage corresponding to the various digging dates:

Effect of Potash on Yield of Sweet Potatoes

Fertilizer P-N-K	Yield per Acre—Bu.			Total Yield per Acre—Bushels
	No. 1	Jumbo	Culls	
8-3-4	230.85	73.25	26.20	330.30
8-3-6	235.30	66.93	26.98	329.21
8-3-8	210.17	79.46	24.50	314.13
8-3-10	234.94	78.25	25.75	338.94

Lower Coastal Plain Station.

4 year average

Rate of application—600 lbs. per acre.

Loss in Storage Due to Frost and Late Digging (Five-year Average)

When Harvested	When Taken from Storage	Per Cent Loss in Storage
October 1	March 25	4.26
October 20	March 25	5.39
2 weeks after hard frost	March 25	44.41

These 5 years' results prove conclusively that digging two weeks or more after a hard killing frost will materially increase the losses in storage. Actual injury to the stem end of the potato or inoculation from the injured stems seems to be the direct cause of such losses.

Effect of Planting Distance on Yield of Sweet Potatoes, R. Schmidt, Leader.

The purpose of this project is to determine the proper distance to space sweet potato plants in the row in order to get a maximum yield of marketable potatoes. As with Irish potatoes, results seem to indicate that the best planting distance depends a great deal upon weather conditions during the growing season. Results of the past season as shown in the following table, favor the 12 to 15 inch space. Close spacing tends to increase the number of culls while the wider spacing favors the formation of jumbos.

EFFECT OF PLANTING DISTANCE ON YIELD OF SWEET POTATOES

Planting Distance	Yield per Acre—Bu.			Total Yield per Acre—Bushels
	No. 1	Jumbo	Culls	
8 inches	263.93	1.43	55.36	320.72
10 inches	287.86	1.07	63.22	352.15
12 inches	314.65	12.86	49.64	377.15
15 inches	309.29	12.50	37.86	359.65
18 inches	286.08	20.00	24.29	330.37

Lettuce Tipburn Investigations, R. SCHMIDT, Leader.

Plants selected in 1928 were allowed to go to seed and this seed was planted for the spring crop of 1929. The season of 1929 was unfavorable for lettuce and a large percentage of the plants developed seed stalks without forming heads. Practically no tipburn developed so it will be necessary to continue the same selections for another season.

J. H. BEAUMONT,
Head, Department of Horticulture

RESEARCH IN POULTRY

THE COST OF PUTTING PULLETS INTO LAY

Experiments have been conducted for a number of years on the cost of putting S. C. Rhode Island Red pullets into lay. These experiments were run on the Coastal Plain Branch Station near Willard, in coöperation with the North Carolina Department of Agriculture. The eggs for hatching, in part of the work were from a flock receiving milk as the sole source of animal feed and the balance from a flock receiving meat meal as the sole source of animal feed.

The meat meal flock received the following laying mash: bone meal, 4 pounds; sodium chloride, 1 pound; meat meal (55% protein), 20 pounds; pulverized oats, 20 pounds; standard wheat middlings, 20 pounds; and corn meal, 35 pounds.

The milk lot received the same with the exeception that milk was substituted for meat meal on a pound for pound basis.

The grain mixture consisted of corn, 50 pounds; heavy oats, 30 pounds; wheat, 20 pounds.

The chicks hatched from the meat meal flock received the following ration: bone meal, 4 pounds; sodium chloride, ½ pound; meat meal, 16 pounds (55% protein); pulverized oats, 25 pounds; standard wheat middlings, 25 pounds; and corn meal 30 pounds. The chicks hatched from the milk fed lot were given the same mash with the exception that the meat meal was replaced with condensed milk on a pound for pound protein basis.

The grain mixture for the chicks and pullets consisted of 30 pounds cracked corn; 20 pounds cracked wheat and 10 pounds cracked hulled oats.

The following data shows the amount of mash, grain, and milk eaten by the chicks each eight weeks period and the cost of same. It also gives the total amount of feed consumed till the pullets commenced to lay and the cost per pullet for feed alone.

DISCUSSION

It required 20.5 ounces of grain, 26.7 ounces of mash and 17.1 ounces of milk per chick for the first eight weeks and for the second eight weeks 63.8 ounces grain, 63.5 ounces mash and 33.6 ounces condensed milk and from the 17th to the 22nd week, inclusive it required 62.7 ounces grain, 62.4 ounces mash and 31.0 ounces milk per chick.

It required 23.8 pounds feed to put the S. C. Rhode Island Red pullet into lay. This feed cost 79 cents.

Each chick ate in the first eight weeks 4.0 pounds feed, and in the second eight weeks 10.0 pounds and from the 17th to the 22nd week, inclusive 9.8 pounds.

In the second trial it required 20 ounces grain and 27.7 ounces of mash and 13.6 ounces of milk per chick for the first eight weeks and for the second eight weeks 61.4 ounces of grain and 56 ounces of mash and 38.8 ounces of

TABLE I

NUMBER CHICKS, FEED AND FEED COSTS, OF MILK FED CHICKS EACH EIGHT WEEKS PERIOD TILL PULLETS COMMENCED TO LAY

Date	No. chicks	Period	Lbs. mash	Cost	Lbs. grain	Cost	Lbs. cond. milk	Cost	Cost per chick	Remarks
6- 7-'27	338	1st 8 wks.	565	$16.44	434	$11.15	361	$20.32	$0.14	
8- 4	209	2nd 8 wks.	830	24.15	828	21.27	440	70.19	0.33	
9-15	123	17 to 22wks.	480	13.96	482	12.36	239	39.79	0.32	First egg 9-12-'27
Totals			1875	54.55	1744	44.80	1040	130.30	0.79	
5- 3-'27	323	1st 8 wks.	559	16.26	405	10.40	276	15.53	0.13	
6-28	173	2nd 8 wks.	606	17.63	664	17.06	420	23.64	0.35	
8- 3	144	17 to 21 wks.	455	13.24	421	10.81	244	13.73	0.27	First egg 8-6-'27
Totals			1620	47.13	1490	38.27	940	52.90	0.75	
4- 9-'27	205	1st 8 wks.	460	14.49	345	10.03	197	11.09	0.11	
6- 4	109	2nd 8 wks.	457	14.39	469	13.64	343	19.31	0.25	
7- 2	82	17 to 20 wks.	190	5.98	199	5.79	175	9.85	0.14	First egg 6-25-'27
Totals			1107	34.86	913	29.46	715	40.25	0.50	
4-20-'28	242	1st 8 wks.	495	13.66	232	7.07	210	10.71	0.13	
6-15	118	2nd 8 wks.	588	16.46	418	12.75	280	14.28	0.37	
7-20	85	17 to 21 wks.	315	8.82	241	7.35	138	6.64	0.26	First egg 7-20-'28
Totals			1398	38.94	891	27.17	628	31.63	0.76	
6-12-'28	314	1st 8 wks.	652	19.85	367	11.19	370	18.87	0.15	
8-16	170	2nd 8 wks.	757	23.16	614	18.72	455	23.21	0.38	
9-18	129	17 to 22 wks.	527	16.12	449	13.69	336	17.13	0.36	First egg 8-20-28
Totals			1936	59.13	1430	43.60	1161	59.21	0.89	
6- 1-'28	278	1st 8 wks.	535	18.02	341	10.81	221	11.27	0.16	
7-27	166	2nd 8 wks.	774	25.23	658	20.85	404	20.60	0.40	
9-14	142	17 to 23 wks.	688	22.42	489	15.40	294	14.99	0.37	First egg 9-19-'28
Totals			1997	65.67	1488	47.06	919	46.86	0.93	
6-22-'28	345	1st 8 wks.	536	17.47	405	12.83	256	13.05	0.12	
8-16	233	2nd 8 wks.	1099	35.82	674	21.36	440	22.44	0.33	
10-12	174	17 to 24 wks.	1050	34.23	835	26.46	460	23.40	0.48	First egg 23rd wk.

condensed milk and from the 17th to the 21st week inclusive 46.7 ounces of grain, 50.5 ounces of mash and 27.0 ounces of condensed milk was consumed.

It required 21.36 pounds feed to put a pullet into lay. This feed cost $0.75. Each chick ate in the first 8 weeks 3.83 pounds feed, the second 8 weeks 9.76 pounds, and from the 17th to the 21st week inclusive 7.77 pounds each.

In the third trial it required 35.8 ounces mash, 26.9 ounces grain and 15.3 ounces milk per chick for the first 8 weeks and for the second 8 weeks 68.8 ounces grain, 67 ounces mash, and 50.3 ounces milk. From the 17th to the 20th week inclusive 38.8 ounces grain, 37 ounces mash and 34.1 ounces milk per chick was consumed.

It required 17 pounds grain and mash and 6.2 pounds milk or a total of 23.2 pounds feed to put a pullet into the laying pen. This feed cost $0.50.

Each chick ate in the first 8 weeks 4.8 pounds feed, second 8 weeks 11.6 pounds and in the 17th to the 20th week inclusive 6.8 pounds each.

In the fourth trial it required 32.7 ounces mash and 15.2 ounces grain and 13.4 ounces milk per chick for the first eight weeks and for the second eight weeks 79.7 ounces mash, 56.6 ounces grain, and 37.9 ounces milk. In the 17th to the 21st week inclusive each chick consumed 59.2 ounces mash, 45.2 ounces grain, and 25.9 ounces milk.

It required 18 pounds grain and mash and 4.8 pounds milk or a total of 22.8 pounds feed to put a bird into lay. This feed cost $0.76. Each chick ate in the first 8 weeks 3.8 pounds of feed, the second eight weeks 10.9 pounds of feed and in the 17th to the 21st weeks inculsive 8.1 pounds per bird.

In the fifth trial it required 33.2 ounces mash, 18.7 ounces grain and 18.8 ounces milk per chick for the first eight weeks and for the second eight weeks 71.2 ounces mash, 57.7 ounces grain and 42.8 ounces milk and the 17th to the 22nd week inclusive 65.3 ounces mash, 56.4 ounces grain and 41.6 ounces milk.

It required 18.8 pounds grain and mash and 6.4 pounds milk or a total of 25.2 pounds feed to put a Red pullet into laying house. This feed cost $0.89. Each chick ate in the first eight weeks 4.4 pounds feed, the second eight weeks 10.7 pounds of feed and from the 17th to the 22nd week inclusive 10.2 pounds feed per bird.

In the sixth trial of the cost of putting S. C. Rhode Island Reds into lay it required 30.7 ounces mash, 19.6 ounces grain, and 12.7 ounces milk per chick for the first 8 weeks and for the second eight weeks 74.5 ounces mash, 53.4 ounces grain, and 30.8 ounces milk. In the 17th to the 23rd week inclusive 77.5 ounces mash, 55.0 ounces grain and 33.0 ounces milk.

It required 19.4 pounds grain and mash and 4.7 pounds milk or a total of 24.1 pounds feed to put a Red pullet into the laying pen. This feed cost $0.93. Each chick ate in the first 8 weeks 3.9 pounds feed, in the second 8 weeks 9.9 pounds feed and from the 17th to the 23rd week inclusive 10.3 pounds feed per bird.

In the seventh cost trial it required 24.8 ounces of mash, 18.7 pounds grain and 11.8 ounces milk per chick for the first 8 weeks and 75.4 ounces mash, 46.2 ounces grain and 30.2 ounces milk for the second 8 weeks. From the 17th to the 24th week inclusive 96.5 ounces mash, 76.7 ounces grain and 42.2 ounces milk.

It required 21.1 pounds grain and mash and 5.2 pounds milk or a total of 26.3 pounds feed to put a Red pullet into the laying house. This feed cost $0.93. Each chick ate in the first 8 weeks 3.4 pounds feed, in the second 8 weeks 9.5 pounds feed and in the 17th to the 24th weeks inclusive 13.4 pounds feed.

The eighth trial using meat meal in the place of milk required 23 ounces mash, 17 ounces grain per chick for the first 8 weeks and 58 ounces grain and 64 ounces mash for the second eight weeks. From the 17th to the 22nd week inclusive each chick ate 65 ounces grain and 75 ounces mash.

It required 18.8 pounds feed to put a pullet into the laying house. This feed cost $0.52. Each chick ate in the first 8 weeks 2.5 pounds feed; second

TABLE II

Number Chicks, Feed and Feed Costs Each Eight Weeks Period Till Pullets Commenced to Lay—Meat Meal Source Animal Feed

Date	No. Chicks	Period	Lbs. mash	Cost	Lbs. gain	Cost	Cost per chick	Remarks
6- 8-'27	328	1st 8 wks.	483	$ 14.05	363	$ 9.32	$ 0.07	
8- 2	197	2nd 8 wks.	795	23.13	717	18.42	0.21	
9-13	114	17th to 22wk.	541	15.74	467	11.99	0.24	First egg 9-12-'27
Totals			1819	52.92	1547	39.73	0.52	
4- 9-'27	311	1st 8 wks.	585	17.02	485	12.46	0.09	
6- 4	160	2nd 8 wks.	779	22.66	681	17.50	0.12	
7-16	116	17th to 22wk.	437	12.71	470	12.07	0.25	First egg 7-17-'27
Totals			1801	52.39	1636	42.03	0.46	
5- 3-'27	253	1st 8 wks.	329	10.36	391	11.38	0.09	
6-28	138	2nd 8 wks.	535	16.85	507	14.75	0.23	
8-16	108	17th to 23wk.	495	15.59	484	14.08	0.27	First egg 8-17-'27
Totals			1359	42.80	1382	40.21	0.59	
4-19-'28	223	1st 8 wks.	335	10.45	188	5.73	0.07	
6-22	117	2nd 8 wks.	584	18.22	454	13.84	0.27	
7-20	81	17th to 20wk.	242	7.55	200	6.10	0.16	First egg 7-27-'28
Totals			1161	36.22	842	25.67	0.50	
5- 9-'28	391	1st 8 wks.	830	6.54	436	13.29	0.05	
7- 4	300	2nd 8 wks.	1030	36.05	715	21.81	0.19	
8-15	156	17th to 21wk.	607	21.18	383	11.69	0.21	First egg 8-8-'28
Totals			2467	63.77	1534	46.79	0.45	
5-28-'28	292	1st 8 wks.	546	19.11	332	10.52	0.10	
7-24	179	2nd 8 wks.	865	30.27	703	22.28	0.29	
9-25	139	17th to 25 wk.	1002	35.07	741	23.48	0.42	First egg 9-27-'28
Totals			2413	84.45	1776	56.28	0.81	
6-16-'29	325	1st 8 wks.	498	17.43	345	10.94	0.08	
8-11	206	2nd 8 wks	945	33.37	675	21.38	0.26	
9-29	110	17th to 23rd.	748	26.18	519	15.45	0.14	First egg 9-28-'29
Totals			2191	76.98	1539	47.77	0.48	

8 weeks 7.6 pounds and from the 17th to the 20th week inclusive 8.7 pounds each.

In ninth trial each chick consumed 30 ounces mash, 25 ounces grain for the first 8 weeks and 68 ounces grain and 78 ounces mash for the second eight weeks. From the 17th week to the 22nd week inclusive each chick consumed 65 ounces grain and 62 ounces mash.

It required 20.5 pounds feed to put a pullet into lay. The feed cost was $0.59½. Each chick ate in the first 8 weeks 3.4 pounds feed, in the second 8 weeks 9.1 pounds and the 17th to the 22nd week inclusive 8 pounds.

The tenth trial of cost of putting S. C. Rhode Island Red pullets into lay required 20 ounces mash and 24 ounces grain per chick for the first 8 weeks and for the second 8 weeks 60 ounces grain and 62 ounces mash and from the 17th to the 23rd week inclusive 71 ounces of grain and 73 ounces of mash.

It required 19.3 pounds feed to put a pullet into the laying house. This feed cost $0.59. Each chick ate in the first 8 weeks 2.8 pounds feed, in the second 8 weeks 7.5 pounds and in the 17th to the 23rd week inclusive 9 pounds.

The eleventh trial required 24.4 ounces mash, 13.4 ounces grain per chick, for the first 8 weeks and for the second 8 weeks 61.2 ounces grain and 80.0 ounces mash and for the 17th to the 20th weeks inclusive 80.0 ounces grain and 47.8 ounces mash per chick.

It required 19 pounds feed to put a pullet into the laying house. This feed cost $0.50. Each chick ate in the first 8 weeks 2.3 pounds feed, in the second 8 weeks 8.8 pounds and from the 17th to the 20th weeks inclusive 7.9 pounds each.

In the twelfth trial of the cost of putting S. C. Rhode Island Red pullets into lay each chick consumed 34 ounces mash, 17.5 ounces grain per chick for the first 8 weeks and 38.1 ounces grain and 54.9 ounces mash for the second eight weeks. From the 17th to the 21st week inclusive 39 ounces grain and 62.2 ounces mash were consumed per chick.

It required 15.3 pounds feed to put a pullet into the laying house. This feed cost $0.45. Each chick ate in the first 8 weeks 3.2 pounds feed, in the second 8 weeks 5.8 pounds and from the 17th to the 21st week inclusive 6.3 pounds each.

The thirteenth trial required 29.9 ounces mash and 18.1 ounces grain per chick for the first 8 weeks and 62.8 ounces grain and 77.3 ounces of mash for the second eight weeks. From the 17th to the 25th week inclusive each chick consumed 66.3 ounces grain and 115 ounces mash.

It required 23 pounds feed to put a pullet into the laying house. This feed cost $0.81. Each chick ate, in the first 8 weeks 3 pounds feed, in the second 8 weeks 8.7 pounds and from the 17th week to the 25th week inclusive 11.3 pounds each.

On the fourteenth trial of the cost of putting S. C. Rhode Island Red pullets into the laying house each chick consumed 24.5 ounces mash and 17.0 ounces grain in the first eight weeks and 52.4 ounces grain and 73.3 ounces mash in the second eight weeks. From the 17th week to the 23rd week inclusive each chick consumed 73 ounces grain and 108 ounces mash. It required 21.7 pounds feed to put a pullet into the laying house. This feed cost $0.71. Each chick, in the first 8 weeks, consumed 2.6 pounds feed and in the second 8 weeks 7.8 pounds. From the 17th week to the 23rd week each chick consumed 11.3 pounds feed.

SUMMARY

In the milk lots it required an average of 22.6 pounds feed to put the birds into lay. This was at an average cost of $0.80 per pullet.

In the meat meal lot it required an average of 19.6 pounds feed to put the pullet into lay. This was at an average cost of $0.59 per pullet.

In the meat meal lots it required an average of 3 months and 10 days and in the milk lots an average of the milk lots 3 months and 2 days. The milk brings the pullets into heavier and slightly earlier egg production in the fall and early winter which is quite a factor as it is a time of year when eggs are a high price.

During the spring and summer of 1929 four more tests were run to determine feed consumption and feed costs of putting S. C. Rhode Island Red pullets into lay, making 18 tests run in the three years. The average of the two meat meal tests—meat meal constituting the whole source of animal feed—was a total feed consumption of 22.82 pounds per pullet at a cost of $0.66. Of the feed 13.51 pounds was mash and 9.31 pounds was grain.

In the case of the milk tests—milk constituting the sole source of animal feed—there was a total feed consumption of 23.30 pounds per pullet at a cost of $0.71. Of the feed 10.02 pounds was mash, 8.81 pounds was grain and 4.47 pounds was milk.

CRATE FATTENING BROILERS

Fourteen lots of chicks totalling 370, were crate fattened during the spring of 1928. The following ration was used: corn meal, 40 pounds; pulverized oats, 40 pounds; meat meal (55% protein) 20 pounds. At feeding time this mixture was made the consistency of batter. Chicks were fed three times a day, giving just what they would clean up in 30 minutes.

The 370 chicks went into the batteries weighing 569 pounds and 364 went out of the batteries weighing 844 pounds. Six died during the fattening period. The 364 chicks made a gain of 275 pounds after absorbing the loss in weight incurred by the death of the six chicks. The average gain was 48.3 per cent.

The average feed cost per pound gain was $0.215. One lot of chicks went bad and made practically no gain. This ran the feed cost up on the meat meal lots. Leaving out this lot of sixteen chicks the average cost was $0.168. Most of the chicks of both milk and meat meal fattening were fed ten days and the chicks came out of the batteries in better marketing condition than when fattened fourteen days, though somewhat larger gains can be secured in feeding fourteen days.

An equal number of broilers were fattened using milk as the sole source of animal feed. The ration was as follows: corn meal, 50 pounds; pulverized oats, 50 pounds. At feeding time one pound mash was mixed with 2 pounds buttermilk or its equivalent in condensed milk. This made the mixture about the consistency of batter.

There were 371 broilers weighing 574 pounds put in the batteries. At the end of ten days 369 with a total weight of 883 pounds were taken out. Seven broilers died and after absorbing this weight there was shown a gain of 309 pounds. The average gain made in this test was 53.8 per cent. The average feed cost per pound gain was $0.17.

The milk fed lots made slightly better gains than the meat meal fed lots, at a feed cost of four cents less per pound gain.

It is observed that in hot weather chicks go off feed quicker when on a milk diet than when on a meat meal diet.

COMMERCIAL FALL BROILER PRODUCTION

Four lots of S. C. Rhode Island Red chicks were hatched during the fall and winter of 1928 and 1929 to determine the costs and sales receipts of broilers raised at that time of year. The chicks were hatched and brooded in electric machines.

The average weight of the broilers at eight weeks of age was 1.35 pounds. At this age 68 of the larger chicks were placed in the fattening batteries and fattened for market and the balance were put in the batteries soon after this time. Both pullets and cockerels were sold for table purposes as they were hatched out of season for pullet production.

The following mash formula was used: yellow corn meal, 40 pounds; pulverized oats, 20 pounds; wheat middling, 20 pounds; 55% meat meal, 16 pounds; bone meal, 4 pounds, iodized table salt, ½ pound. The grain consisted of cracked corn, 30 pounds; wheat, 20 pounds and hulled oats 10 pounds.

The first three days the chicks were given one-half pound condensed butter milk to the 100 chicks per day. This was mixed with mash, using enough mash to make the mixture crumbly moist. The chicks were fed three times a day till the fourth day after which the dry mash was kept before the chicks at all times. Condensed milk was mixed with mash and fed twice a day till the end of the first week. After this time condensed milk was spread on a board one inch by four inches and fastened against the wall of the house so the chicks could eat but could not get their feet in it.

The loss by death from all causes was 9 chicks or 3.1 per cent. Of this number 4 died of natural causes and 5 were caught by hawks.

These chicks consumed 723 pounds mash up to the time they were placed in the fattening batteries. The cost was $3.28 per hundred pounds, or a total of $23.86. Another 289 pounds mash was consumed during this time at a cost of $2.98 per hundred pounds or a total of $8.59. This makes a total of 1012 pounds mash consumed to the battery fattening age at a cost of $32.45. One hundred and forty-six pounds grain at a cost of $3.00 per hundred and 410 pounds grain at $2.67 per hundred pounds makes a total cost for grain to time of fattening of $15.23. There was used 50 pounds condensed buttermilk to start the chicks at a cost of $2.55, making a total feed cost $50.33. It required 326 k.w.h. of electricity used by the brooder at four cents per k.w.h. or a total of $13.04. Four hundred and ninety-four eggs were used and charged at 5 cents each or a value of $24.70. The cost of incubating was $6.92. Five hundred and seventy-one pounds mash was used in fattening at $2.92 per hundred amounting to $16.67. Total costs including crate fattening $111.66. One hundred and twenty broilers weighing 267 pounds brought 35 cents a pound in Durham, total return $93.45. Forty-two broilers weighing 94 pounds brought 35 cents a pound in Wilmington, total returns $32.90. Twenty broilers weighing 48 pounds sent to Washington, D. C. brought 40 cents losing 7 pounds shrinkage, total returns $16.40. Eighty-eight broilers weighing 204 pounds sold at the plant at 32 and 33 cents a pound bringing total returns $65.96. Express charges to Durham $4.46; to Washington, $2.35; to Wilmington, $2.94 making a total of $9.75. Gross receipts for the 270 broilers was $208.71. Labor income on the venture $97.08.

FARM FLOCK MANAGEMENT

The birds at the Coastal Plain Station were S. C. Rhode Island Reds and divided into two flocks. One flock received milk as the sole source of animal feed and the other meat meal. In the year November 1st, 1928 to October 31st, 1929 the meat meal flock averaged 116 birds. There was laid during the year 15,901 eggs, an average of 136 per hen per year. The highest producing hen laid 222 eggs. There was 4,544 pounds mash consumed costing $140.41. There was 5,904 pounds grain consumed during the year costing $145.07. Three hundred pounds grit was also used at a cost of $4.13. Number pounds animal protein consumed per hen per year 4.27. The feed cost per dozen eggs was $0.21. Average price obtained for the year $0.398 per dozen.

In the milk fed flock there was an average of 102 birds and an egg production of 13,405 eggs. The average number of eggs laid per hen per year was 130 with the highest producing hen laying 228 eggs. There was consumed 3.038 pounds mash costing $80.70 and 5,349 pounds grain mixture costing $132.28. There was also consumed 3.760 pounds condensed milk costing $171.86 and three hundred pounds grit costing $4.13. Amount animal protein consumed per hen per year was 4.2 pounds. The feed cost of producing one dozen eggs was 34 cents.

Total cost and receipts for the whole year's operations including broilers, pullet and cockerel sales, and eggs for table and hatching is as follows: Cost of feed $2,429.20, Sundry supplies $491.17, marketing costs $54.05, eggs incubated $256.63, value of stock 11-1-'28 $936.35, value of eggs and feed 11-1-'28 $85.18, use of truck $30.00, sowing green feed $30.00, broilers brought to fill orders $51.20, equipment bought $40.24. To balance against this for receipts on sales we have value of eggs sold $1154.42, broilers sold $1739.01, pullets sold $1299.50, cockerels sold $88.90, cull poultry sold $268.03, equipment sold $7.50, credit to sundry expenses $3.10, credits to feed sold $5.20, value of stock for sale 11-1-'29 $367.30, value of breeding stock $864.00, 1 barrel milk $19.27, eggs incubating $30.95, value of poultry fertilizer $40.00, empty bags $5.00. Labor income from the year's work with poultry $1488.16.

HATCHERY EXPERIMENTS

W. F. ARMSTRONG

The purpose of these experiments is to determine some of the problems confronting the hatchery operators as follows:

(a) General fertility of all breeds.

(b) Fertility and hatchability of individual breeds.

(c) Comparison of fertility and hatchability of fertile eggs and of all eggs set according to breeds.

(d) Seasonal fertility—all breeds.

(e) Seasonal hatchability—all breeds.

(f) Relation of fertility to hatchability.

(g) Comparison of hatchability in cabinet and deck machines.

(h) Effect on hatchability of exposing eggs to direct sun rays at intervals during incubation.

(i) The effect of turning eggs during incubation.

(j) The hatchability of eggs according to interior quality.
(1) Light yolks.
(2) Dark yolks.
(3) Dislocated air cell.
(4) Blood spots
(5) Watery albumin

During the past season 29,586 eggs were used which brought the total for the four year period to 56,620 eggs. The three year period shows a 91.2 per cent fertility for all breeds. The four year period shows 88.9 per cent or a loss of 2.3 per cent. Practically all individual breeds lost a few points in this respect except Leghorns with a gain of 2.2 per cent. Rocks remained about the same and Orpingtons showing the greatest drop with 8.5 percentage points lost over the four year period compared to the three year totals.

Hatchability of fertile eggs show a slight drop for all breeds while Orpingtons and Rocks show an increase of 3.6 per cent and 7.1 per cent respectively.

Seasonal fertility records do not as yet have a sufficient number of eggs set each week to warrant consideration. The same applies to seasonal hatchability, comparison of hatching in deck and cabinet machines, and turning eggs during incubation. The effect of direct sun rays on incubating eggs has not been started due to the lack of equipment.

The problem of determining the hatchability of eggs according to interior quality has been conducted one year and shows that while the dark yolk eggs have five per cent better fertility and one per cent less mortality of embryos, they did not show a better hatch of all eggs set. The light yolks show about five per cent better hatch of fertile eggs than do the dark yolks and though this is a rather wide range, it is believed to be within the margin of possible variation for the number of eggs used. Blood spots apparently do not affect hatchability, but not enough eggs have been used to draw definite conclusions. None of the eggs with dislocated air cells or those with watery albumin hatched.

DISEASE INVESTIGATION

R. S. Dearstyne

During the year 1928-29, poultry disease investigations have largely centered on the septicaemic diseases of fowls which includes Pullorum Disease (Bacillary White Diarrhea) and Avian Typhoid, two diseases which are responsible for great losses among the poultry flocks of North Carolina. Both these projects are of a long time nature due to the fact that a number of generations of birds must be studied in order to thoroughly understand transmission possibilities, and that the duration of infection in the soil, one of the important objects of these projects, will require a number of years observation in order to measure the longevity of such infection.

During the past year, Technical Bulletin 36 "Study of Bacillary White Diarrhea was published by the station as a contribution from the Poultry Department. In this bulletin is summarized the latest findings on this disease, which brings out the following:

1. Effects of the Disease on Egg Production. From an egg production standpoint, the reactor may be profitable in the pullet year. Great variations

in production are experienced according to the designation of the disease and the site of focalization of the infection. Continuation of this specific phase since the publication of the above bulletin indicates a complete collapse of the flock under study in the hen year, which indicates greater designation of the disease as the bird matures.

2. Serological Studies. Serum titre did not appear to be influencing egg production to a noticeable extent. There appears to exist a relationship between mean serum titre of reactors and hatchability of fertile eggs. In this connection, a study of 12 months of bi-monthly serological tests on 25 reactors is divided into the following three groups: Group 1 with a mean serum titre of over 1:200; group 2 with a mean serum titre of from 1:100 to 1:200 and group 3 with a mean serum titre of less than 1:100. The hatchability of 218 fertile eggs from group 1 was 28.4 per cent; from group 2 it was 3.4 per cent of 187 fertile eggs and 45.5 per cent of 303 fertile eggs from group 3.

3. Effects of the Disease on Hatchability and Livability of Progeny. This phase of the study brings out the fact that, aside from disease dissemination, the reacting hen is uneconomic as a breeder. Of 757 fertile eggs incubated at various intervals during the spring of 1929, only 258 or 37.5 per cent hatched. Of this number, 203 or 71.2 per cent died of the disease, the majority succumbing during the first week after hatching.

4. Analysis of Eggs Laid by Reacting Birds. During the period of study of pullorum disease at this station, 12,894 eggs from reacting birds have been examined for the infecting organism. Of this number, 1626 or 12.6 per cent proved positive. In a study of the eggs from pullets bred from reactors on both sides, 824 or 21.0 per cent of 3,898 eggs proved positive which indicates that such breeding may accentuate the ratio of egg infection. These figures bring out the danger of reactors in a breeding flock.

5. Studies of the Development of Progeny of Reactors. Ninety-two chicks hatched from reacting birds were studied up to 6 months of age. These are divided sexually, of this number 31 or 62 per cent of the cockerels showed positive agglutination test within 6 months after testing with 30 or 75 per cent of the pullets showed the same response. It appears that there exists a tendency for cockerels to be more resistant to the disease, which fact is born out in field testing. Agglutinations against the disease are demonstrated at a relatively early age, as 22 or 46 per cent of the cockerels and 21 or 51 per cent of the pullets were positive at 2 months of age. The significance of this work may be seen in the fact that 66.3 per cent of the living progeny of reactors developed into reactors in a short time after hatching, which brings out the danger of the reactor in the breeding flock.

6. The Susceptibility of the Carrier of Pullorum Disease to Avian Typhoid. Theoretically a bird which is a carrier of pullorum disease has an active acquired immunity against this specific disease and also against fowl typhoid which is a closely related disease. The relationship between the causative organisms of these diseases is demonstrated in vitro (test tube) by agglutinating antigens of the organisms against the antiserum of the related organisms in question. This immunity proved non-specific in vivo (in body), the organism of fowl typhoid being injected intra-venously into carriers of

pullorum disease, and two of three such birds so injected succumbed to the disease in 3 days, while the third contracted the disease but threw it off and recovered. In the case of injection of S. pullora directly into the blood stream of carriers of this disease, no mortality occurred although clinically symptoms indicated body disturbance. In this study it was demonstrated that agglutination occured in vivo.

7. Transmission of the Disease by Adult Carriers Through Other Avenues Than Infected Eggs. During the course of the year, one bird of eight negative pullets confined with a flock of adult reactors for the last eight months has proved positive to the agglutinin test and has laid infected eggs. The range on which this experiment occurred had never been occupied by birds prior to the time of this study, and brings out the fact that a negative bird may contract the disease by contact with adult reactors. Whether this case developed through infected droppings or through copulation with a positive male is not known.

One of the reactors under study for over a year died and autopsy findings proved the bird to have a generalized septicaemia. In such a condition, it is entirely possible that the bird voided virulent organisms, and that the reactor mentioned above may have been the result of picking up such droppings.

SEROLOGICAL STUDIES ON ADULT REACTORS

Eighteen months' studies on the serum titre (degree of reaction) of carrier birds brings out the fact that there is a definite rythmic fluctuation in serum titre which seems to occur periodically. This fact has brought out the question as to whether or not there is not periodic septicaemias occurring in adult carriers with agglutination taking place in vivo. If such be the case, adult birds may be infecting the soil at such times. This phase is now undergoing investigation.

DEVELOPMENT OF INTERMITTENT REACTORS

This phase of pullorum disease is probably one of the most important factors in the adoption of control measures. Study of 24 birds from reacting parents show that only six reacted after the first time of test, which indicates, although only limited numbers may be quoted, that 75 per cent of the carriers react intermittently to the agglutination test during the early stages of life. These studies also brought out the fact that all carriers would have been eliminated in six tests if the tests were applied monthly and the dilution used did not exceed 1:25.

Acting on the basis of these studies, the State Department of Agriculture has adopted a new method of control of this disease, and are doing intensive testing, with certain groups in the state, in order that there may be a number of flocks and hatcheries accredited during the coming year, which should assure a source of chicks free of pullorum disease.

STUDIES ON AVIAN TYPHOID

This work is being continued on the basis reported in the Station report of 1927-28. A new lot of birds have been raised to place on ground which has been artificially infected with avian typhoid, under conditions simulating the natural. These birds have been vaccinated, and the studies under

progress at the present time is to make observations as to the duration of immunity conferred by vaccination of birds when ranging on heavily infected soil. It is hoped that out of the studies under way that more efficient methods of immunization may be brought out in the way of dosage and necessary frequency of vaccination, also in the longevity of infection in the soil.

OTHER STUDIES ON POULTRY DISEASES

In March, 1929, Bulletin 264 was published as a contribution from the Poultry Department. The bulletin is designated as "Causes of Poultry Mortality in North Carolina" and is a classification of the causes of mortality of poultry in North Carolina as brought out by the autopsy work conducted by the department.

The bulletin deals with per cent incidence of the numerous disease conditions of poultry and their seasonal occurrence.

Among the findings brought out in this bulletin are:

1. That digestive disorder was the primary cause of death in 865 or 48.1 per cent of 1,800 birds classified, and that more stress should be placed on careful feed practices.

2. There is exhibited a seasonal tendency for occurrences of respiratory and septicaemic diseases, which tendencies are shown by graphs. Stress is laid on the poultryman acquainting himself with the seasonal occurrences of these diseases in order that he may anticipate them and be prepared to combat them.

3. That mortality from nutritional diseases is shown to have a tendency for seasonal occurrence, which fact may be traced to the lack of green feed supplements during the seasons of the year when green feed is not available.

4. That mortality from muco-enteritis and from intestinal fermentation shows a seasonal influence and is apparently due to indifferent feeding practices.

5. There is indicated a relatively heavy incidence of intestinal parasitic infestation among the flocks of the state, this showing 24.8 per cent ascaris infection; 13.8 per cent taenia infestation and 4.7 per cent spiroptera infestation.

B. F. KAUPP,
Head Poultry Department.

RESEARCH IN ZOOLOGY AND ENTOMOLOGY

The research work in this department has progressed very satisfactorily during the past year.

PROJECT No. 1—BIOLOGY OF THE LEAFHOPPER

This project was discontinued as an active project at the end of the fiscal year because the leader of the project under our present scheme of oranization has only a very limited period of time to devote to this project.

The chief result from this project has been a study of the species of leafhoppers injuring peanuts in the peanut sections of the state and in all six species have been found doing more or less damage to this crop and one of them, the so-called bean leafhopper, is a serious pest, producing the disease known locally as "pounts" which resembles in its general aspects the disease known as "tipburn" on potatoes which is caused by the same insect. Another species which is common on a variety of grasses is frequently injurious in fields that have not been properly cultivated. A third species, the so-called clover leafhopper, seems to be increasing as a peanut pest and may prove to be of economic importance.

Some work has been done on the pecan spittle insect and as this is a very important pest in the pecan orchards of the state more work should be done on its life history and on its control.

A considerable amount of work has been done on the grape leafhopper on scuppernong grapes and on the two most important apple leafhopers in the mountains.

A generalized study of the life history of the willow spittle insect, a European species introduced in the vicinity of Boston, has been made and suggestions for its control have been published.

In addition to the small amount of economic work that has been done a considerable amount of work has been done during the period of this project on the taxonomy of the group. A general review of the plant hoppers of Eastern North America has been published and a number of small papers dealing with various aspects of the taxonomy of this group have been published. In addition a thorough study was made of the bibliography of this group and a paper including some thirty-five hundred titles is ready for publication. A catalogue of the species of this group from all parts of the world has been maintained. This catalogue will constitute some of the parts of the Catalogue of the Hemiptera of the World, which is being published by Smith College.

Z. P. METCALF, *Leader.*

PROJECT No. 3—THE CORN ROOT WORM

The rotation experiments for the control of the corn root worm were continued at the Pender Branch Station. The first planting and the replanting were so badly damaged by corn bill bugs that no conclusions

could be drawn. A thorough study of the life history was made during the summer and the indications are that these studies will lead to better methods of control. The fact that the eggs from the overwintering adults are laid early in the spring would seem to indicate that winter plowing and fallow cultivation might be satisfactory. This method should be tried out for several seasons.

Z. P. METCALF, *Leader.*

PROJECT No. 4—CORN EAR WORM

In this year's experiment at the central farm on the effect of planting time on earworm injury, corn was planted April 20, May 1, May 10, and May 20. The percentage of ears showing infestation were respectively 92, 96, 97, and 98.5. The slight benefit in favor of the earliest planted corn was more than offset in the early summer by a heavy infestation of larger corn stalk borer which was somewhat less severe on the corn planted May 1 and caused very little damage to the corn planted May 10 and May 20. Southern corn root worm also caused more severe injury to the earlier planted corn.

In experiments for the control of corn earworm on sweet corn the following devices were tried: Covers for the silks of cheese cloth, mosquito bar and paper cones; clipping the silk after pollenation and treating cut ends with poisons; injections into the tip of husk with lead arsenate, sodium fluosilicate, lead arsenate and corn meal, paradichlorobenzene and Dupont repellant No. 43. Most of these methods proved to be of no value. The cheese cloth covers gave the best protection but the number of tests was so small that further experiments will be necessary before any conclusions can be drawn as to the value of mechanical protectors.

B. B. FULTON, *Leader.*

PROJECT No. 6—WINTERING OF BEES

This project has been continued for several years so that average conditions will be more nearly found upon which recommendations to the beekeeper can be made.

During this period of time results from previous experiments have been arranged so that we are able to draw up the following general conclusions which are based on the difference in brood, bees and food at the beginning of winter and the same at the close of the winter period. Colonies of bees containing as few as fifteen ounces of bees have been carried through the winter in the packing case, and unprotected ones with one pound, one and one-half ounces. These do not have surplus honey the following spring. The types of protection giving best results for an average of four winters are listed as—first, double walled hive; second, packing case; third, unprotected; and fourth, paper packed. The average number of days in the winter period was one hundred and thirty-three.

Data for this year have not been tabulated in proper form for conclusions but it seems advisable to continue this project with more stress to be placed on honey production from colonies wintered by special methods.

F. B. MEACHAM, *Leader.*

PROJECT No. 7—A SURVEY OF THE HONEY PRODUCING PLANTS OF THE STATE

This project has been continued from year to year so that data might accumulate and variations in seasons could be checked.

We have available information giving the exact blooming dates for our main honey plants, the period of full bloom and the duration of bloom. This is true for several stations scattered over the state. In this locality an average colony is placed on a pair of scales and the change in weight of this colony is correlated with the honey plants blooming. In other sections the value of certain plants as nectar producers has been estimated in the reports. Many more reports are needed to make this project complete and it seems well worth while to continue, as many fundamentals of successful beekeeping depend upon a proper knowledge of the honey producing flora.

F. B. Meacham, *Leader.*

PROJECT No. 8—THE BEES OF NORTH CAROLINA

The results of a project such as this one for any single year are usually unimpressive, this being by nature and of necessity a long-time project. A comprehensive knowledge of any group of animals, such as the bees, together with some insight into the possible importance of the group as an economic factor, is obtained only by a gradual accumulation of collected material and associated data. Some progress was made, however, during the past year, as collection were made at several points in the state as well as in the environs of Raleigh. The project is followed only as a part-time activity and progress made is largely dependent upon the time available and upon opportunities to collect in varying types of localities and at various seasons.

T. B. Mitchell, *Leader.*

PROJECT No. 20—THE TAXONOMY AND BIOLOGY OF THE LEAF-CUTTER BEES

During the past year additional material has been received from various parts of the United States and Canada, as also from Europe and South America. The total number of specimens identified and studied has mounted to approximately 20,000 from all parts of North America as well as a number from Europe, and several thousand from Central and South America and the West Indies. In all this material about sixty North American species new to science have been discovered and many more from Mexico and South America. It has been found inadvisable to restrict the scope of the project geographically for several reasons. First, this genus (Megachile) is cosmopolitan in distribution and includes a very large number of species, probably between 3,000 and 5,000, and many of these have wide geographical ranges, so that some species occurring in tropical America, for example, may be also found within the boundaries of the United States. Moreover, no definite theories regarding the natural grouping of species within the genus can be formulated without a general knowledge of the genus as an entity, in its world-wide sense, since these smaller groups are more often

than not represented in two or more major faunal regions. It is the firm belief of the leader in this project that insect taxonomy, which is the foundation upon which all other entomological sciences are built, will be much more rapidly developed and will more nearly represent the true facts of insect relationships, if specialists narrow the range of their activities so far as the insect groups are concerned but observe no limit as to geographical boundaries. Insects do not observe political boundaries and a study of any natural group is not complete if it disregards any species belonging in the group from any part of the world.

As an economic factor, this genus has a two-fold potentiality: First, it is potentially beneficial, since the species collect pollen and nectar from flowers and are thus important agents in cross-fertilization of many kinds of flowering plants, this being also true of most of the bees, social or solitary; and second, it is potentially injurious, because many of the species have the habit of lining their nests with cut pieces of leaves, this sometimes resulting in complete defoliation of trees under the right combination of circumstances.

Work is now in progress on the manuscript of a revision of the genus as it occurs in North America, and many new species from South America and Mexico have been described in manuscript, to be published in the near future.

T. B. MITCHELL, *Leader.*

PROJECT No. 22—STUDIES IN HUMAN INHERITANCE

The purpose of these studies is to add to our knowledge of hereditary human factors, and to make this knowledge available in a practical way. The work has been centered around the hereditary character known as the blood groups, since they provide a constant and stable starting point. The year's work has included further investigations on the groups themselves. From this work we have been able to construct serologic laws applying to legal medicine, clinical medicine, and anthropology. In several instances assistance has been rendered in various hospitals in the state in regard to transfusions. In a number of instances information as to legal tests on blood has been given.

In addition to the blood groups, studies have been made on other human characters, chief among these being migraine. The factor for migraine (a form of "sick headache") was found to be a dominant hereditary factor, transmitted according to definite Mendelian laws, and probably inherited independently of the blood groups. Other hereditary factors (polydactylism, eye color, occipital hair whorl, fatty tumors, etc.) have been studied, and are being investigated statistically.

The available information on the blood group project has been written up in book form, and is being published by the Williams and Wilkins Co., of Baltimore.

L. H. SNYDER, *Leader.*

PROJECT No. 24—HARLEQUIN BUG

Observations on host selection by the harlequin bug has led to recommendations for the growing of a winter crop of rutabagas to serve as a trap

crop in the spring and to attract the bugs away from cabbage, collards and other crops. It was found that most of the over wintering adult harlequin bugs would remain on the rutabagas in the spring and deposit their eggs there. The rutabagas begin to dry up about the time the first of the spring generation of bugs are maturing and at this time it has been recommended that the tops be thoroughly sprayed to kill the bugs and thereafter cut and burned to destroy the remaining eggs.

Further experiments on soap solutions have shown that the killing efficiency of such sprays are indirectly proportional to the rate of atmospheric evaporation. Two per cent solutions of several brands of white laundry soaps have been shown to be nearly a hundred per cent effective in killing harlequin bugs hit by the spray, under conditions of less than .008 c.c. of evaporation per minute from a standard atmometer bulb. The same sprays are entirely ineffective under conditions of .04 c.c. or more evaporation per minute. In the light of these results it has been recommended that spraying for harlequin bug with a 2 per cent soap solution should be done only on very humid days or early in the morning when dew is on the plants and never when a strong breeze is blowing.

It was found that the soap solution killed the harlequin bugs only when it penetrated deeply into the tracheae. The adult insects have spiracles equipped with closing devices which impede the entrance of the soap solution. By coloring the solution with India ink the degree of penetration of the tracheae could be observed. It was found that the bugs that died from the effects of the solution had the thoracic tracheae largely filled with the solution. Entrance usually took place through both pairs of thoracic spiracles and to a less extent through the first abdominal spiracles while the remaining abdominal spiracles remained filled with air. When the treated insects did not die in the usual length of time it was found that no solution had entered through the spiracles or that partial penetration had taken place through only one or two of the four thoracic spiracles. Immature harlequin bugs have spiracles with only rudimentary closing devices and the solution enters more quickly and through both thoracic and abdominal spiracles.

The same relation of evaporation to efficiency of soap sprays has been found to hold true for some other insects and is believed to be of general application. For this reason the usual practice of spraying during fair weather should be changed when using a soap solution. Soap solutions of from ½ to 2 per cent, depending on the insect to be sprayed, are very effective and considering their universal availability and non-poisonous nature could be more extensively used for home gardens.

B. B. FULTON, *Leader.*

RESEARCH IN RURAL SOCIOLOGY

Research in rural sociology is somewhat different from most other agricultural research. Seldom will it be possible to pick a recommendation out of a piece of rural social research and plan to put it into practice the following year. Rural Sociology deals with the life and organization of the people who live on farms and in farm communities. The type of life farm people live is the ultimate index to and measure of any system of farming, whether it be a system for a whole agricultural area or of a single farm family. Research in Rural Sociology, therefore, seeks to discover and, in as far as possible, to measure in quantitative terms the type, level or standard of life which prevails in given rural areas or under certain systems of agriculture, and by means of various types and kinds of social institutions and community organizations. It also seeks to measure the factors associated with these farm levels of living. Once these quantitative measures of the rural standard of living are made, rural sociologists believe that they can construct trustworthy indexes of the agriculture of the region.

At this station a long time program of research in rural sociology has been planned, the pursuit and completion of which will contribute materially to the objectives stated above.

The first project, 1926-27, was an analysis of the living conditions prevailing among white farm owners in Wake County. In Bulletin No. 258, by Dr. W. A. Anderson, the findings of this study were presented.

The next step was to obtain data for a comparative study of the levels of living among white owner and tenant operators. Records were gathered from 300 white tenant families in addition to the 294 white owner records used in the previous study.

During the year 1927-28 two analyses of these schedules were made by Dr. Anderson. The manuscripts of these two studies are now in the press. The one study is a comparative analysis of farm family living in the two groups, while the other study is a technical analysis of some of the factors influencing the living conditions among these same farmers.

Due to Dr. Anderson's absence from the college during 1928-29 no further field work was done on the Wake County Study. During 1928-29 Dr. Carl C. Taylor gathered the field data and practically completed a study of community organization in seven typical North Carolina counties during the year. This study attemps to discover the factors of success and factors of failure in local community organizations of all kind, economic, social, etc. The manuscript for this study will be completed during the year 1929-30.

As the next step in the pursuit of our long time program of the analysis of Standards of Living a series of projects is now under way by which study an analysis is being made of the influence of community agencies and institutions on farm family living. These studies are being conducted by Drs. Anderson and Taylor, and with the assistance of Mr. Charles P. Loomis.

Preliminary study is being made of the types of churches, schools, stores, banks and other social agencies serving these farm families, while the

mobility of farmer's sons and daughters and the type of farm homes is also being analyzed. After these preliminary analyses, indices of the institutions and agencies will be computed and related to various indices of family living to discover the degree of association existing between the two sets of factors. Studies will be continued during the years 1929-30, and 1930-31.

The study of coöperative marketing membership relations has not been completed. It is the purpose of the Department to complete this study and do some supplementary studies on the three projects mentioned above as soon as the 1929-30 project is completed.

It is the opinion of Drs. Anderson and Taylor that the next step in the long time project on the Standard of Living should be a detailed "case study" of probably 25 tenant families and 25 owner families. The purpose of this study would be to discover factors not accounted for in the previous studies on this project and to discover if possible how some farm tenants and farm owners raise their standard of living and how and why others fail to do so.

CARL C. TAYLOR,
W. A. ANDERSON,
Department of Rural Sociology.

FINANCIAL STATEMENT

The following is a certified statement of the receipts from the Treasurer of the United States, supplementary funds from the State Department of Agriculture, and sales from the Station farms with a record of their disbursement:

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In account with the UNITED STATES APPROPRIATION, 1928-1929.

Dr.

	Hatch Fund	*Adams Fund*	*Purnell Fund*
To receipts from the Treasurer of the United States, as per appropriation for the fiscal year ended June 30, 1929, under acts of Congress approved March 2, 1887 (Hatch Fund), and March 16, 1906 (Adams Fund), and February 24, 1925 (Purnell Fund)	$15,000.00	$15,000.00	$50,000.00

Cr.

Salaries	$13,313.00	$11,970.00	$31,691.99
Labor	345.39	469.40	2,616.69
Stationery and Office Supplies	13.05	15.73	154.60
Scientific supplies, consumable	16.15	681.97	563.72
Feeding stuffs	....	3.50	4,520.49
Sundry supplies	81.82	174.21	356.39
Fertilizers	....	2.60	335.46
Communication service	23.82	12.46	58.67
Travel expenses	913.81	717.53	5,336.26
Transportation of things	27.16	60.82	169.92
Publications	....	....	1,882.96

Heat, light, water and power	$	$ 72.03	$ 38.39
Scientific equipment	172.49	512.83	601.45
Livestock	....	....	713.77
Tools, machinery and appliances	93.31	306.92	363.66
Buildings and land	....	....	594.00
Contingent expenses	....	....	1.58
	$15,000.00	$15,000.00	$50,000.00

THE NORTH CAROLINA AGRICULTURAL EXPERIMENT STATION,
In account with FARM AND MISCELLANEOUS RECEIPTS.

Dr.

State Department of Agriculture	$60,000.00
Sales	14,242.22
Miscellaneous	7,401.71
Total	$81,643.93

Cr.

Salaries	$45,319.31
Labor	6,536.28
Stationery and office supplies	543.25
Scientific Supplies, consumable	715.42
Feeding stuffs	4,454.29
Sundry supplies	1,526.16
Fertilizers	1,199.98
Communication service	723.57
Travel expenses	6,897.25
Transportation of things	484.06
Publications	2,156.53
Heat, light, water and power	807.01
Furniture, furnishings, and fixtures	458.23
Library	713.80
Scientific equipment	117.33
Livestock	2,379.30
Tools, machinery and appliances	1,698.36
Buildings and land	2,040.50
Contingent expenses	715.93
Unexpended balance	2,157.37
Total	$81,643.93

We, the undersigned, duly appointed auditors of the expenditures from Federal appropriations reported herein, do hereby certify that we have examined the books and accounts of the North Carolina Agricultural Experiment Station for the fiscal year ended June 30, 1929; that we have found the same well kept and classified as above; that the balance brought forward from the preceding year was *nothing* on the Hatch Fund, *nothing* on the Adams Fund, and *nothing* on the Purnell Fund; that the receipts for the year from the Treasurer of the United States were $15,000.00 under the act of Congress of March 2, 1887, $15,000.00 under the act of Congress of

March 16, 1906, and $50,000.00 under the act of Congress of February 24, 1925, and the corresponding disbursements $15,000.00, $15,000.00, and $50,000.00; for all of which proper vouchers are on file and have been by us examined and found correct, leaving balances of *nothing*, *nothing*, and *nothing*, respectively.

And we further certify that the expenditures have been solely for the purposes set forth in the acts of Congress approved March 2, 1887, March 16, 1906, and February 24, 1925, and in accordance with the terms of said acts, respectively.

(Signed)

R. Y. WINTERS,
Director of the Experiment Station.

A. F. BOWEN, *Treasurer*,
Financial Officer of the Institution.

A. S. BROWER,
Comptroller of the College.
Auditors.

(Seal)

Attest:

A. F. BOWEN,
Custodian of the Seal.